The Mining Magazine

PUBLISHED AT SALISBURY HOUSE, LONDON.

INDEX TO VOLUME XX.

FROM JANUARY TO JUNE, 1919.

EXPLANATORY NOTE.—Items in italics are names of books reviewed; illustrated articles are denoted by asterisks (*); the letters (*m.d.*) refer to notices of articles under the heading "Mining Digest."

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.SC., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill*, both Editions

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago.

SUBSCRIPTION { U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XX. LONDON, JANUARY, 1919. No. 1.

CONTENTS.

EDITORIAL

WHAT can we say as a message for the New Year that has not already been said? The disappearance of the official Liberal party at the polls takes the leadership of labour out of the hands of politicians who cared little or nothing for the classes they claimed to represent. Labour is now represented by men who have risen from the ranks, and who will be ready to reject the tactics based on political expediency, if the more educated and more fortunate members of the community meet them with the respect due to fellow men. With regard to the results of the war, none is of so far-reaching importance as the new friendliness between England and the United States. The Englishman never considered the American as a foreigner, and he used to feel sad that, under the promptings of mischief makers, the American should occasionally doubt the sincerity and virility of the inhabitants of the old country. It was worth while fighting, if for nothing else than to send up the Englishman in the esteem of the American, not only as a source of gratification, but because it has made it possible for America to cast aside its aloofness and to join in the federation of the world. The visit of President Wilson to this country was a big event in the days of big events, and the nature of his reception cannot be gauged by the amount of bunting displayed or by the volume of voices in the crowds. We can apply to him his own words spoken at Carlisle, and recognize him as one who can turn us away from the savagery of self-interest to the dignity of the performance of the right. We see the same characteristics in Mr. Lloyd George. While these two men can exercise influence among the English-speaking race, the prospects for the future will be bright, the horizon will be unclouded, and there will, after all, be "some blue hills that are really blue."

THE Institution of Mining and Metallurgy has been appointed by the Ministry of Labour the central authority to select the "pivotal" men to be released under the scheme of prior demobilization in so far as it affects professional men of the metal-mining and non-ferrous metallurgical industries. This will enable employers, on application, to obtain the release at the earliest date possible of previous members of their technical staffs. The Institution has already prepared lists showing the experience and qualifications of members of the profession who are, or have been, members of the Forces. The Institution will by this means be able to serve as a centre for introducing technical men to those who have positions to offer. Employers are invited to take advantage of this opportunity to secure the services of qualified men.

IN this issue we give the third and concluding article by Mr. George C. Klug on ore-dressing practice at Broken Hill. This article describes the new plant at the British Broken Hill mine, a plant which embodies all the latest improvements in the concentration of lead-zinc-silver ores.

LAST October, Mr. J. A. Mac Vicar wrote us an article on the history of the diamond-drill's performance in Cornwall. In this issue we reproduce a paper he read in December at a meeting of the Cornish Institute of Engineers, which gives much interesting information relating to the cementing of loose and broken ground encountered by the drill. We hope Mr. Mac Vicar will continue to impress on Cornishmen the desirability of penetrating beyond the working face.

LORD Montagu of Beaulieu has written to *The Times* advocating an international agreement as to the rules of the road. In England, the pedestrian's instruction is to keep to the right, while the drivers of vehicles have to keep to the left. In other countries the rules are various, but generally the drivers have to keep to the right side of the road. We hope Lord Montagu's proposals will be adopted. It is appropriate in these days to remember the virtue of keeping to the right. A bishop of olden time, when asked, all of a sudden, for a concise spiritual guidance, told his questioner to take the first turn to the right and go straight on; and many a music-hall artist has told us that we shall never go wrong if we keep to the right. Lord Montagu, as spokesman of the motor-car fraternity, might well impress his fellows with the necessity of recognizing the foot passenger's "right" of way.

MANY technical papers have suffered by the war. It is a wonder that most of us have been able to keep going. As an instance of the strength of English institutions, we may quote the case of *The Geological Magazine*. This paper was founded over fifty years ago, and Dr. Henry Woodward has been editor all this time. We wrote a short paragraph acknowledging his great services to geology when fifty years were completed a few years ago. His magazine had a hard struggle for existence during the war, owing to the cost of paper and printing. Moreover, Dr. Woodward is no longer young, having reached the age of 87. We record with pleasure the appointment of Mr. R. H. Rastall as assistant editor, who will surely continue the old traditions. Mr. Rastall is well known as the part-author of the "Text book of Geology" and the "Petrology of Sedimentary Rocks."

MINING engineers have done much for their country during the war. Their work does not appeal to the man in the street in the same way as the exploits of the airmen, or the adventures of the Vindictive, but none the less it contributed in no small measure to the success of the campaigns. It is gratifying to put on record Sir Douglas Haig's letter of appreciation, wherein he thanks the engineers for their services and speaks of the high quality of their performance: "A large number of men are now being withdrawn from Tunnelling Companies for urgent work at home. Before they leave the country I wish to convey to the Controllers of Mines and to all ranks of Tunnelling Companies, both Imperial and Overseas, my very keen appreciation of the fine work that has been done by the Tunnelling Companies throughout the last four years. At their own special work, mine warfare, they have demonstrated their complete superiority over the Germans, and whether in the patient defensive mining, in the magnificent success at Messines, or in the preparation for the offensives of the Somme, Arras, and Ypres, they have shown the highest qualities both as military engineers and as fighting troops. Their work in the very dangerous task of removing enemy traps and delay-action charges, on subways, dug-outs, bridging roads, and the variety of other services on which they have been engaged, has been on a level with their work in the mines. They have earned the thanks of the whole Army for their contribution to the defeat of the enemy. Their fighting spirit and technical efficiency has enhanced the reputation of the whole Corps of Royal Engineers and of the Engineers of the Overseas Forces. I should also like to include in the appreciation the work done by the Army Mine Schools and by the Australian Electrical and Mechanical Mining and Boring Company."

THE report of the Government committee on gold production is disappointing in more than one sense. In the first place it shows that the banking authorities never intend to give more than the present price for gold, or to recommend the Government to grant subsidies to low-grade mines. In the second place, the students of economics have to regret that the committee did not enter into any argument, detailing the reasons for refusing to pay more than par for gold, and explaining the nature of the results, evil or otherwise, of such a step. To put the matter figuratively, as befits the occasion, the Gold Producers' Committee has been wrecked on the Inchcape Rock. In our November issue we gave considerable space to the gold-producer's side of the question, so it is only fair to give the committee's views in full, even if they are somewhat bald and unsatisfying. Readers will find the report quoted at length in another part of this issue. Briefly the committee's view is that the world's output of gold is not seriously threatened, that the subsidizing of low-grade mines would benefit foreign gold-buyers only, and that the owners of gold mines should not shout now, seeing that in the past they reaped big advantages over the owners of base-metal mines owing to the fixed price of, and unlimited demand for, their product. As we have said, the committee has shied at an exposition of results that would follow a rise in the price of gold, the members contenting themselves with the statement that it did not seem a sound business transaction to give £4. 10s. for something worth only £3. 17s. 10d. This reminds us of the device adopted by the youth who is stuck in his examination paper; when he is not sure of the argument at some step in a geometrical problem, he writes: "It is therefore perfectly clear that—etc.," and so arrives at the desired conclusion. To others than the bankers' committee does the result of raising the price of gold present an insoluble problem. With Strephon, who was a fairy down to the waist but mortal below, may they exclaim; "What will happen to the rest of me when my legs die of old age, I'm sure I don't know."

The Position in Russia.

The present conditions in Russia are causing many people a great deal of anxiety, and surprise has been expressed that the Allies do not undertake a campaign of repression against the Bolshevists, and thus bring about a settlement of affairs in Eastern Europe. There is some tendency to exaggerate the power and resources of the Bolshevists. As for a campaign against the Bolshevists, such a thing would be difficult to organize in the winter, and in any case it could not be undertaken until the Germans have filled their agreement to withdraw from all countries that they had over-run. The pity of it all is that the educated classes in Western Russia are being gradually exterminated, cold and hunger doing this work as well as gun, sword, and fire. Galicia, Poland, and eastern Germany are also in turmoil, and here again the malificent influence of the German intriguer and dealer in revenge is clearly indicated. These questions will loom large at the Peace Conference, and they will have to be settled there.

From the point of view of the mining engineer, the Russian difficulty is not so serious. In reviewing the recent events of the war, it becomes clear that the Bolshevik rule among the Ural and Siberian mines was short-lived. The metals were not stolen wholesale, and the wilful damage was small. The Czecho Slovak prisoners helped to restore order. Many of the races from Orenburg to the Altai, Mussulmans of Arabic origin, took no part in the revolution. After several unsuccessful attempts, a responsible Government that shows signs of stability was established at Omsk. This Government has handed back the mines to the owners, and has promised compensation for damage when financial conditions permit. The latest news indicating the strength of this Government comes from Perm, where a Bolshevik army was put to rout and many prisoners captured. It seems clear, therefore, that the country east of the Volga is rapidly progressing toward settlement, and this being the condition the Japanese forces feel free to withdraw. As regards the Caucasus region, the Turks have not fully retired, so it is too early to say anything of the position in Armenia and Caucasia. The state of the coal and iron mines in the Ukraine presents no great anxiety. In both Caucasia and the Ukraine the presence of the Allied fleets in the Black Sea exercises a wholesome influence. It is in Petrograd, Moscow, and the Baltic provinces where the danger to civilization lies. Not until the spring, and the Baltic reopens to navigation, can pressure be brought to bear in these regions. The want of clothing and food may by then have provided a cruel solution of the difficulty. In any case, the nations represented at the Peace Conference will have decided before the arrival of spring on some course of effective policy.

The German Colonies.

Amid the excitement of the General Election, the visit of the President, and the spending of a really happy Christmas, the issue of a Government White Paper relating to the future of the German colonies from the native inhabitant's point of view was overlooked by the press and the public. Perhaps this absence of interest was not due to any of the causes named, but to the fact that nobody considers the question at issue to be open to argument. Nevertheless it is well to glance through this White Paper and to read the opinions, nay, the supplications, of the natives who were under the rule of the Germans. Here we see, in concentrated form, the evidence and result of the Teutonic contempt for the weaker races. The Germans sought possessions in the Tropics as sources of raw materials that would minister to their comforts at home. They considered the native male population solely as instruments for reaping these natural resources, and the females as objects for their lustful passion. The wishes and the happiness of the people were not considered. Both men and women were forced or whipped to their allotted fate. Is it likely that they would want their cruel oppressors back again ? Take the Samoans for example, as quoted in the White Paper. They say the British officials who took charge of the islands have treated them with love, allow them to win cases in the courts, and ask for their views before deciding on new or revised regulations. King Bamun, of the Cameroons, petitions for British rule, and demands that Germans and "all other unclean things" shall be driven out. The Hereros, in South-West Africa, tremble for their lives at the very idea of the country being German again. They say that in times past it was their constant prayer that the Almighty would send a deliverer from the cruelties to which they were subjected. If the British King takes his soldiers and government away, they will leave the country and follow the troops wherever they go. The Herero men have been robbed of their wives and daughters. The girls have been interfered with by Germans when quite young. There are more bastards in Tsumeb than pure-blood Herero children. The cattle were stolen, the men driven to work before the lash and the gun. The record of experience of the inhabitants of Togoland was just the same. The Germans made the men work without pay, and also collected a poll-tax from them. The men were collected into gangs and were moved from one part of the country to another, with total disregard of personal desire or tribal custom. Any land of special value was acquired by the Germans by forced sale, and the purchase price was never paid. Said a Chief: "I like freedom to sleep well in my house: it is like a dream coming true to see the English coming back again." The natives of the island of Nauru, in the Pacific, beg that King George will keep them as his children, and under such circumstances will consider themselves as having been newly born in the year 1914. And so on, we might quote from nearly sixty pages of foolscap size, with echoes of past cries of pain and horror on all of them, and entreaties to be saved from the old oppressors. Truly here is the evidence that the German colonist was a callous tyrant and brutal governor. The term "savage" is more appropriate to this white beast than to the untutored and simple-minded inhabitant of the jungle, the desert, and the isles of the Tropics.

There are other good arguments in favour of retaining the German colonies. They would all be hotbeds of intrigue and the dissemination of false and disquieting rumours and reports, calculated to sow internal dissensions and create distrust among the friendly nations of the world. They would moreover serve as bases for sneaking naval operations that would be able to paralyse transport on the seas. But it is not necessary to elaborate these additional arguments. Their consideration may safely be left to the Peace Conference. We have given our own argument, based on the treatment of the natives; and, after all, as the old Greek philosopher remarked, one good reason is enough. No! It won't do! The German must not be allowed his place in the sun until he knows that its rays are beneficent, shining alike on the rich and the poor, the powerful and the lowly.

Finance After the War.

The Minister of Munitions appointed a committee in November, 1917, to discuss the provision of financial facilities for trade after the war, Sir Richard V. Vassar-Smith, head of Lloyds Bank, being chairman. Last month this committee issued a report, full of useful suggestions. It is not within our province to review all the proposals, nor have we the space to do so, seeing that the report of another committee, that dealing with the encouragement of gold production, claims priority on our attention. There are two items, however, in the report to which reference should be made. One is the suggestion that Treasury control of new issues of capital should not be entirely relaxed. We desire to associate ourselves with this recommendation, and we strongly urge the Government to continue to exercise control over the issue of shares by mining companies. This control has been guided during the war with much shrewdness and wisdom, and not only have the irresponsible promoters been repressed, but many of the proposals emanating from responsible houses have also been given their quietus, when those proposals were solely for the object of encouraging stock-market operations. It may seem odd that a Magazine claiming to represent the mining fraternity should ask for limitations and restrictions of this character; but the fact is there is too much company-mongering and watching the markets in London, and far too little thought given to the actual business of mining, and any step taken that will tend to rectify this improper influence and make mining shares less of gambling counters and more of tokens of legitimate enterprise is welcomed by us.

The second point raised in the report relates to the participation of banks in commercial undertakings. Under present banking conditions it is deemed undesirable to grant long credits of this sort. The only way to make it possible to adopt such a practice, on anything like an extensive scale, would be to encourage deposits for long periods and at fixed interest. In December, 1916, we made a suggestion on these lines when discussing the formation of the British Trade Bank. We then recommended that banks should inaugurate "No. 2" deposit accounts, carrying fixed interest, and withdrawable only at long date, from one to five years. As a matter of fact, the banks are always open to business of this sort, and as the present report says, it only wants encouragement and advertisement on the part of the banks to obtain a great expansion of this method of investment. Some of the financial papers have expressed a doubt as to the attractiveness of such a proposal. No doubt the commercial and financial houses, and others, who keep a deposit account, require it in liquid form; but on the other hand many businesses, especially where the assets are intangible, as in the case of goodwill, the fixed deposit account would provide an excellent medium for investment for the replacement of paper capital. Private individuals would surely find such an investment attractive, and trustees would consider it a real godsend. There were some people who doubted the need or call for the Public Trustee; others prophesied the failure of War Savings Certificates and of the Post Office issues of the War Loan and War Stock. In both cases have the lugubrious prognostications been falsified. It only requires a judicious advertising campaign on the part of the banks, after the country's needs for war expenditure are filled, to divert a large share of commercial and individual savings to the fixed deposit account. Thus shall we all have the privilege of contributing our share toward the capital required for establishing and fostering many industrial enterprises, and thereby help to expand and strengthen the trade of the Kingdom.

Manufacture at the Source of Raw Material.

One of the influences of the war, and one that is by no means of small importance, has been the tendency to establish factories and works near the source of raw material in various parts of the world. The cause of this change of policy has not been the direct appreciation of a fundamental law of economics, but the serious position of the communities due to the shortage of shipping, and the necessity of either eliminating transference of commodities from one place to another, or of reducing the weight and bulk of the materials shipped. This forced alteration in the distribution, though highly inconvenient, has had the effect of drawing attention to the law of economics to which we refer, and for this reason many of the steps taken to manufacture on the spot instead of exporting raw material and importing finished products will be continued and the new schemes made permanent. In no country will the new industries be of greater advantage than in Australia, where the well-known policy of fostering the local production and use of the metals and their products is being followed in connection with many other industries. If this decentralization of manufactures can be extended, the money and effort expended on the moving of material from one place to another will be substantially saved, the congested populations will be distributed in a happier manner, and the producers and consumers will alike receive a larger share of the results of their labours.

When the original emigrants and world-adventurers sailed from the old shores, they took their commodities with them for their use and comfort. On settling abroad they sent raw materials home in order to maintain a constant supply of their own requirements. As time went on and the volume of interchange of goods increased, special facilities were provided in the way of transport, exchange of money, and agencies for import and export, and gradually the ship-owners and the railway companies, the bankers, and the merchant houses grew rich and powerful, in most cases becoming of greater commercial importance and influence than the original people for whom they acted as intermediaries. The settlers abroad often longed for opportunities for establishing their own manufactories in order that they could reap the results of their labours, but unfortunately the intermediaries had more capital or control of capital than they had, and naturally the intermediaries would not finance new businesses that would cut the ground from beneath their own feet. The United States is the only new country that has been able to establish home industries to such an extent as to render it self-supporting and economically independent of the rest of the world, so as to permit its inhabitants to enjoy fully the many benefits bestowed by nature. This change was not effected easily, but by most strenuous effort against the whole forces of the old-established commercial houses and ship-owners. Neither the riches of the supplies of raw materials nor the native wit of the American availed, in themselves, to establish home industries, and it was only by the imposition of a heavy tariff on imports that the desired end was eventually achieved.

Australia has had less opportunity to establish herself as a producer of manufactured goods, seeing that she is a dependency of Great Britain, and representatives of the home interests used to have almost exclusive access to the ears of the political controllers of the situation. It is only during the last few years that the Australians themselves have had the opportunity of rearranging matters in such a way that the country shall receive greater advantage from the raw materials. Under the guidance of Mr. W. M. Hughes, the ores and metals have been put under the firm control of the Commonwealth Government. Ore and concentrate are not to be exported if there is any chance of their being treated locally, and the metals produced are also to be utilized on the spot as far as possible and as opportunity arises. An example of this move toward the manufacture of final products is provided by the formation of a company controlled by the English white-lead firms for the purpose of establishing such an industry in Australia. It seems illogical that metallic lead should be sent from Port Pirie to England and returned to Australia as white lead and other lead pigments. It is not, however, the Government solely that has taken the initiative in working ores and producing metals, for a large share of the credit is due to the Broken Hill Proprietary for founding the steel industry at Newcastle, New South Wales. In this case also it was illogical that the great Iron Knob deposit should be allowed to lie fallow, and at the same time steel rails should be imported from England for the construction of railways. One of these days tinplates and galvanized iron will be made by the Proprietary company in association with experienced firms in the old country. At the present time Australian tin travels to England to be used in the manufacture of tinplate. The tinplate goes back to Australia to be employed in canning beef and fruit, which in turn is exported to England. Thus the Australian tin makes three journeys across the seas when only one is necessary. Who benefits by this triplication of the journey? Not the miner and the agriculturist nor the consumer.

An industry perhaps of even greater importance to Australia is that of wool-growing. The Australian wool production is the largest in the world, but it benefits comparatively a very few people within the Commonwealth, for the wool is shipped abroad to many countries to be worked up into cloth and similar materials, some of which go back again to clothe the Australians. It is pleasant to be able to record that steps have been taken to remove this anomaly, and that before long a local woollen industry will be flourishing.

In other countries under the British flag the same tendency is to be observed. For instance, the Cape Copper Company, which developed a copper mine in India, intended to ship the concentrate to the smelter at Britonferry, South Wales. War conditions have made it more advisable to erect a blast-furnace, converter-plant, and refinery on the spot, and no doubt a local market for the refined copper has been secured. Then the Burma Corporation is to smelt zinc ores, and, in alliance with Tata & Sons, to manufacture galvanized iron and brass. The Tata steel enterprise is another example of the local treatment of mineral resources, though its establishment was not prompted by war conditions, but by appeciation of the general principle of economics to which we have referred.

In South Africa little has been done to treat or use the natural resources of the country locally. The copper mines had to suspend shipment of ore and matte to this country, but their ore reserves and prospects did not justify the erection of smelters. Some of the iron deposits have been developed and small smelters erected. The tin mines in the northern Transvaal have built smelters so as to avoid the cost of shipping concentrate to Singapore or Penang, and the tin is used locally for the production of solder and similar alloys. But the great mineral production, that of gold, is still exported, and the credits it creates are mostly lost to the country of its origin. The country, in fact, suffers from a form of absentee landlordism. It is true that the expenditure at the mines affords an income to support a population, but the capital results accrue elsewhere.

A great simplification in the distribution of metallic products has taken place in connection with the tin output of South America. Bolivian tin concentrate used to be shipped to Europe, partly to England, and much of the metal extracted by the smelters was shipped to New York for consumption among alloy makers in the United States. The first step in shortening the circuit was to erect smelters on the eastern seaboard of the United States, and to send the Bolivian concentrate direct. Subsequently it has been found advantageous to establish smelting works near the mines in the Andes, and to manufacture tin-lead alloys on the spot in order to provide for the demand from the Argentine, Chile, and Peru. In this way the carriage and sale of the metal has been greatly facilitated and simplified.

In writing these short notes on one particular phase of economics, we do not lose sight of the fact that there are many other factors governing the production, distribution, and utilization of mineral and other natural products, factors both sociological and commercial. It is difficult to steer clear of by ways and keep to the highways, and to avoid both the proverbial red-herring trailed across the track and the tendency to walk in a circle where there are no definite landmarks. The thesis in this article is that under present conditions the controller of transport, the exchange banker, and the import and export merchant get too big a slice of the benefits of nature, to the detriment of the producer and consumer, and that the shortage of shipping caused by the war has tended to right an economic disadvantage. On some future occasion we may revert to another aspect of the subject, and show that the best scientific and technical ability in the world is devoted to the requirements of those engaged in transport, and that, in his own home, the actual producer and worker gets precious little benefit from the applications of science to the manufacture of good material.

REVIEW OF MINING

Introduction.—The beginning of a new year finds us in the middle of an armistice, with a definite peace settlement some distance away. With uproar in Berlin and a German-Bolshevik reign of terror in north-western Russia, Poland, and eastern Germany, the final elimination of fighting and an agreement as to boundaries and the nature of future methods of government do not seem easy of attainment. Under such circumstances the return of the soldiers to their ordinary avocations must not be hurried. The change over, in this country, from munition making to ordinary industrial enterprises will necessarily be slow. The metal markets have been released from government control, and the markets are uncertain and restricted. Copper has fallen substantially in price. Tin also fell severely, but has since strengthened again. With metals so weak and erratic, the producers are far from feeling sure as to the future. The idea of gold-mining receiving assistance by subsidy or by a rise in the price of gold has received its quietus from the Inchcape committee.

Transvaal.—The native labour contingent at the gold mines decreased seriously in November, the figures at the end of the month being 160,275, as compared with 173,153 at the end of October, and 179,399 at the end of September. The figures for December had not arrived when we went to press, but it is not likely that there will be any improvement, seeing that in several quarters recruiting has been stopped.

The dividends paid by Rand mining companies for the second half of 1918 show a serious shrinkage. This is due partly to the increased costs now prevalent, partly to the adverse effects of the influenza epidemic, and partly to the fall in the yield, gross and per ton, of many of the old mines. The number of companies paying dividends during 1918 amounted to 33, out of the 50 producing mines, as compared with 38 during 1917. The total distribution for 1918 was £5,330,000, as compared with £6,556,000 in 1917, and £7,093,000 in 1916. Amid this general decline, it is pleasant to note that some of the Far East Rand mines have increased their distributions during the second half of 1918. New Modderfontein, the greatest gold mine of the Rand at present, has paid 24s. as compared with 17s. 6d. for the first half, making 41s. 6d. per £4 share for the year, as compared with 28s. for 1917. Government Gold Mining Areas, Modder Deep, and Geduld have paid rather more. On the other hand, Modder B and Brakpan have not been able to maintain the 1917 figures. It is disappointing to find Crown Mines only paying 6d. per 10s. share for the half-year, which is at the rate of 10% per annum, and City Deep paying only 1s. 6d. as compared with 4s. 6d. during the latter half of 1917. As a token of encouragement, Springs Mines makes its entry into the list of cash-dividend payers, paying 2s. 6d. per share for the second half-year. It, however, distributed a dividend in the form of West Springs shares, paid for out of cash reserve, earlier in the year. The accompanying table gives particulars of distributions during 1918, with corresponding figures for 1917 as far as the companies named are concerned. Five companies have dropped out of the list this year, namely, the New Goch, Knights Deep, Witwatersrand Deep, New Primrose, and Ginsberg.

DIVIDENDS PAID BY TRANSVAAL COMPANIES.

RAND.	1917 1st half	1917 2nd half	1918 1st half	1918 2nd half
	s. d.	s. d.	s. d.	s. d.
Brakpan	4 6	5 0	4 0	2 6
City Deep	4 6	4 6	4 0	1 6
City & Suburban (£4)	5 0	3 0	1 6	—
Consolidated Langlaagte	2 0	1 6	—	1 0
Consolidated Main Reef	1 0	1 0	9	6
Crown Mines (10s.)	2 0	2 0	1 6	6
Durban Deep	6	8	6	—
Ferreira Deep	3 6	2 3	2 3	2 3
Geduld	1 0	1 0	1 0	1 3
Geldenhuis Deep	2 6	1 6	1 0	6
Glencairn	—	—	—	1 0
Government Gold Mining Areas	—	2 6	2 6	3 0
Jupiter	9	9	—	3
Langlaagte Estate	1 0	1 0	1 0	1 6
Meyer & Charlton	10 0	12 0	10 0	12 0
Modderfontein (£4)	13 0	15 0	17 6	24 0
Modderfontein B	8 0	9 0	8 6	8 0
Modderfontein Deep	8 0	9 0	9 6	10 0
New Unified	1 6	1 6	1 0	1 0
Nourse Mines	1 3	1 3	9	—
Robinson Deep "A" (1s.)	4 0	—	2 0	—
Robinson Gold (£5)	3 6	4 0	1 6	1 0
Rose Deep	2 6	3 6	2 0	1 6
Simmer & Jack	9	6	3	—
Springs Mines	—	—	—	2 6
Sub-Nigel	1 6	1 6	1 4	1 0
Van Ryn	3 6	2 6	1 0	1 0
Van Ryn Deep	4 0	4 6	4 6	4 6
Village Deep	1 6	1 9	9	—
Village Main Reef	2 0	2 0	2 0	—
Witwatersrand	4 0	3 0	2 0	1 0
Wolhuter	1 3	1 0	9	6
OUTSIDE RAND				
Glynn's Lydenburg	2 0	2 0	1 9	1 6
Transvaal Gold Mining Estates	1 0	1 0	9	6

As recently recorded, the Durban-Roodepoort mine is exhausted and the company has gone into liquidation. The liquidators have announced that realization of assets warrants an interim return of capital amounting to 10s. per share, and this will be distributed at the end of the current month.

The Consolidated Mines Selection company has received permission from the Public Trustee to acquire the enemy holdings. These shares are to be offered to other shareholders at the rate of one for every three now held, and the price is to be 25s.

The East Rand Mining Estates is a company usually known to the public as the owner of the Lewis & Marks gold-mining rights in the Far East Rand, the properties being the Grootvlei, Palmetkuil, and Vlakfontein. The company, however, owns coal rights also. Bore-holes have proved the existence of coal beds in the south-eastern part of Grootvlei and in the adjoining part of Palmetkuil. A company called the Largo Colliery Co. Ltd. has been formed to work the property, with a capital of £110,000, the whole of which is issued as purchase price to the East Rand Mining Estates.

The Zaaiplaats is one of the Transvaal companies that has erected a tin smelter. The results obtained as regards quality of the metallic tin have been highly satisfactory. Provision has been made for buying concentrate produced by other mines in the neighbourhood, but so far this branch of the business has not developed owing to unexpected difficulties. During the year ended July 31 last, 17,078 tons of lode ore was milled and 5,494 tons of alluvium was treated. The total yield of tin concentrate was 521 tons. The amount of concentrate bought was 25 tons. The output of metallic tin was 328 tons. The working profit was £52,185, out of which £19,288 was spent on capital account, £10,000 was placed to reserve, and £19,125 was distributed as dividend, being at the rate of 30%.

Though developments at the Rooiberg tin mine have been disappointing latterly, it was possible during the year ended June 30 last to keep half the stamps running. The tonnage milled was 16,509, and the yield was 361·7 tons of concentrate. In addition, 2,193 tons from Blaauwbank gave 31·7 tons; while 11,151 tons of old slime gave 86·5 tons. The total yield was 480 tons, which sold for £85,334, and the working cost was £77,936. Mr. E. R. Schoch, the manager, speaks hopefully of the Blaauwbank property recently acquired.

At the meeting of shareholders in the Middleburg Steam Coal & Coke Co., Mr. Alfred T. Macer, the managing director, again drew attention to the fact that at the South African coal mines a large proportion of the output is not utilized, the dust and fine coal being placed on the dumps. This, of course, was the practice in the older coalfields in Europe and America, where nowadays the small coal is either briquetted, used for coal-dust firing, or converted into gas with accompanying liquid and solid by-products. For some years Mr. Macer has advocated the establishment of a big central plant for the Witbank-Middelburg district, by means of which this fine coal could be utilized for the manufacture of gas for power and of sulphate of ammonia, benzol, etc. We urge the Government of the Union of South Africa to give consideration to Mr. Macer's proposal.

Rhodesia.—Probably Rhodesia has suffered more than any other country from the influenza epidemic. The returns for November show a big shortage, the figures being £145,458, as compared with £136,780 in October, £247,885 in September, and £275,829 in November, 1917. Other figures for output in Southern Rhodesia during November were: silver 10,499 oz., copper 147 tons, coal 31,541 tons, chrome ore 1,245 tons, asbestos, 294 tons, scheelite 1 ton, wolfram 1 ton, arsenic 3 tons, diamonds 53 carats.

West Africa.—The gold returns for November show that the effects of the influenza epidemic have mostly passed away. The output was valued at £108,796, as compared with £61,461 in October, and £115,152 in September. The total for the first eleven months of the year was £1,220,932, as compared with £1,407,375 for the first eleven months of 1917.

In these days of gold-mining depression, it is pleasant to come across a cheery report like that of the Taquah company. Development has maintained the reserves both in quantity and value, and the working cost per ton has not gone up, the figure remaining at 36s. 11d. The percentage of recovery is 98. The manager, Mr. G. W. Campion, naturally feels proud.

The Taquah's stable companion, the Abosso, has ore of lower grade, the average being 33s. 3d. per ton, as compared with the Taquah's 55s. 9d., and the gold is not so easy to extract. No profit was made for the year ended June 30. It is gratifying that recent developments on the West Reef have disclosed ore of rather higher content, 1,340 ft. of development being in ore averaging 38s. 1d. per ton over 50 inches.

Nigeria. — As mentioned last month, the Niger Company has made a new issue of capital to keep pace with the expansion of business. The issue was of 575,000 ordinary shares of £1 at 42s. each. The directors avoided risk of failure by getting the issue underwritten, but this proved in the event to have been unnecessary, for applications exceeded the amount offered. The shares are being allotted pro rata to applicants who are already holders of ordinary shares.

A year ago we published an article by Major A. R. Canning describing the properties of the Northern Nigeria (Bauchi) company. In it he mentioned that the company was contemplating the erection of a hydro-electric power plant at the Kwall Falls. At the meeting of shareholders held last month, he gave some additional information relating to this scheme. The river passes through the properties, and, at a distance of 10 miles to the west, drops over the edge of the plateau, falling more than 700 ft. The power generated is to be 1,500 h.p., and its cost is estimated at 0·6d. per unit, as compared with 2·6d. if oil or coal were used. The company may, by its means, expect to save £40,000 a year in the power bill. The installation is to be built by the firm of Vickers, who sent an engineer to Nigeria to investigate and report,

The Bongwelli is a tin company operating in Nigeria that did not have much luck with its first properties. New business promises to resuscitate its fortunes. Further properties on the Delmi river have been obtained, and a representative of the Niger Company is to be elected to the board.

In our November issue, Mr. W. E. Thomas gave some particulars of the Nassarawa tin district of Northern Nigeria. We are now able to record that the company of which he is manager, the Keffi Tin Co., has made a profit of £16,389 for the year ended June 30 last, from an output of 160 tons of tin concentrate, and out of this, £6,250 has been distributed as a first dividend, being at the rate of 12½%.

Australia.—The report of the Mount Elliott company affords dismal reading to those who hope for better things from labour leadership. It is true that 80% of the men in the Queensland smelting industry are of a high type, but unfortunately the minority has the control. Mr. W. H. Corbould has been at his wits' end to manage the properties in such a way as to make a profit and also to please the men, even reducing the size of the blast-furnace so as to bring it to dimensions which they thought proper. It is no wonder that the result of the year's working to June 30 last was a financial loss of £56,890. The furnace was running less than seven months, and extracted 2,322 tons of blister copper from 51,952 tons of ore. The company owns many excellent mines. All that is wanted is a labour party which will let men work and allow the adoption of metallurgical improvements.

Cable messages announce that the Mount Morgan output of ore during the half-year ended December 1 was 186,032 tons, in addition to which 9,328 tons of fluxing ore was extracted from Many Peaks. The concentration plant treated 115,466 tons, giving 41,321 tons of concentrate. The smelter treated 68,237 tons of ore, 10,003 tons of jig concentrate, and 26,432 tons of table and flotation concentrate, mostly sintered. The yield was blister containing 3,580 tons of copper and 42,842 oz. of gold. By means of modifications in concentration, it is not now necessary to use the basic fluxing ore brought from Many Peaks, and the contract with the Many Peaks Company has therefore been terminated. The agreement for the sale of the copper to the Ministry of Munitions in London ended on December 31. The future policy with regard to sales has not yet been settled.

The Electrolytic Zinc Co. of Australia is about to enlarge its plant at Risdon, Tasmania. The present plant has a capacity of 90 tons per week. This is to be expanded to 100 tons per day, and the plans are being prepared. For the extension, further hydro-electric current will be required. This will be obtained from the Tasmanian Government Hydro-Electric Department; 11,000 h.p. will be available in about a year and a quarter's time; and an additional 15,000 h.p. at a later date not yet specified. The last-named supply of current will be used also for other chemical and metallurgical industries.

During the six months ended June 30 last, the Amalgamated Zinc (De Bavay's) company treated 164,719 tons of zinc tailing from the North and South mines at Broken Hill, for a yield of 47,184 tons of zinc concentrate averaging 48·2% zinc, 6·4% lead, and 9·1 oz. silver per ton, and 1,834 tons of lead concentrate averaging 53·2% lead, 12·5% zinc, and 65·9 oz. silver per ton.

India.—Developments in depth at the Champion Reef mine are at present entirely disappointing in all sections, and it would appear that the bottom of the lode as well as of the ore-shoots has been reached. In the ore-shoot between Carmichael's and Glen shafts, nothing of value has been found between the 57th and the 59th levels. In Glen section, the ore-shoot became impoverished below the 55th level, and at the 57th level the lode is weak. The shoot in Garland's section is poor on the 51st, 52nd, and 53rd levels. During the past year the ore reserve has been fairly well maintained by ore developed on the 53rd, 54th, and

55th levels in Carmichael's section and on the 54th and 55th levels from Glen shaft; also by some old pillars having been made available for stoping by the close-filling method recently adopted. The reserve is estimated at 335,949 tons, or about 2½ years' supply. The amount of ore treated during the year ended September 30 last, and the gold extracted, showed a continuance of the shrinkage of recent years; 138,030 tons of ore yielded 76,835 oz. by amalgamation, and 205,320 tons of tailing yielded 17,403 oz. by cyanide. The total yield realized £399,505, and £69,333 was distributed as dividend, being at the rate of 26⅔%. Since the beginning of operations in 1892, the tonnage treated has been 4,089,440, the yield £13,027,598, and the dividends £4,582,299.

Malaya. — The Malayan Tin Dredging Company is fully up-to-date in the engineering problems of dredging, having the advantage of the advice of Messrs. F. W. & R. Payne. It is noteworthy, therefore, to find that the manager speaks highly of the close-connected bucket-line recently installed on No. 2 dredge. He says that, on the experience so far gained, this system marks a decided advance on the old type. Thus the New Zealanders see the virtues of the American design, where such design is applicable to the conditions of work.

Cornwall.—After a long struggle, the Basset mine is to be closed. Want of capital, heavy pumping charges, and thirty years of adversity have combined to bring this decision. No doubt, also, the decision was hastened by the death of Mr. Francis Oats, who was chairman for a quarter of a century. The mine is on the Great Flat Lode south of Carn Brea hill, a lode which, in times past, was second only in importance to the Dolcoath lode. In early days the mine produced copper, but 70 years ago tin became the leading product.

Canada.—The Mond Nickel Co. has issued an additional 1,520,000 preference shares, 7%, non-cumulative, of £1 each, at par. The capital thus provided will be used to complete the extension of the refining works at Swansea, and thereby increase the output of the various products by 50%. The shares were offered to the public and largely over-subscribed.

United States.—Another report has been made by Mr. F. W. Bradley as to the flooding of the Alaska Treadwell, 700 Ft., and Mexican mines, which happened in April, 1917. It appears from this report that the caving occurred on the shore of the Gastineau Channel along one of the decomposed basaltic dykes which cross the vein near the east end of the Treadwell property. It is now believed that the flooding took place during a period of high tide, and that it may be possible to build a dam near the line of low tide and to pump the water out of the mine. This would appear to constitute a hopeful feature of the situation, but Mr. Bradley damps the reader's enthusiasm by adding that it is questionable whether such work is worth doing. He also says that he cannot decide this question until more is known of the value in depth of the ore in the Ready Bullion mine. This mine is at some distance along the lode from the flooded mines, and it has been kept going continuously, affording a revenue for the Alaska United. An extensive campaign of development at depth has been inaugurated, and levels are to be opened at 2,600 and 2,800 ft. The ore on the 2,400 ft. level averages as high as in any level above. It will be remembered that in the lower levels of the Treadwell the ore was of very low grade and gave little encouragement. There was, however, a large ore reserve in the upper levels, containing several million dollars' worth of gold. It is surprising that Mr. Bradley does not consider this ore worth reclaiming by the suggested unwatering of the mine. But perhaps it is in the form of pillars that could not be removed without fear of another collapse.

The export of copper from the United States is in future to be in the hands of a central controlling committee called the Copper Export Association. Mr. John D. Ryan is president, and Mr. Simon Guggenheim chairman of the board.

It is stated that platinum and palladium are found in important quantities in the copper ore of the Rambler mine in Wyoming, 45 miles south-west of Laramie. The average assay of the ore is 5% copper, 0·4 dwt. gold, 1 oz. silver, 0·4 oz. palladium, and 0·6 oz. platinum.

Chile.—Political difficulties between Chile and Peru continue unabated, and Peruvians are being driven out of the northern provinces of Chile. It will be remembered that the provinces of Tacna, Arica, and Tarapaca formerly belonged to Peru. Tarapaca, where the nitrate deposits are, was ceded to Chile in 1879 as a war indemnity, and in 1883 the other two provinces were occupied by Chile, with a proviso that ultimate ownership should be decided at some future date by plebiscite. One point in dispute is whether the plebiscite shall be confined to the original inhabitants or be extended to recent immigrants. The Chileans are endeavouring, by persecution, to rid the Tacna and Arica provinces of as many sympathizers with Peru as possible.

TUNGSTEN AND THE WAR

By JULIUS L. F. VOGEL, M.Inst.M.M.

We print in full a paper read at the British Science Guild Exhibition on August 30, 1918, by the metallurgist who founded the British tungsten industry.

IN the far off pre-war days the importance of tungsten as an essential ingredient in the manufacture of tool steel and as a corner stone of modern engineering was only fully realized by a few technical men. From time to time they sounded a note of warning of the danger of this country depending upon Germany for its supplies, but, as in the case of many other essential industries, their warning was unheeded. The very name of tungsten was practically unknown to the man in the street, the merchant, the banker, the member of Parliament, the Cabinet Minister, and in fact to all those to whose hands were entrusted the destinies of the British Empire.

To-day this is altogether changed. Tungsten, regarded apparently as one of the great discoveries of the British nation aroused to arms, has been investigated by Committees, controlled, departmentalized, and dignified by inclusion in the select ranks of the key industries. I am by no means sure that lionizing in this way will prove to have been to the advantage of the industry in the long run.

In giving a short account of tungsten from the point of view of general interest, I think it is best to work backward and to give some idea of its properties and uses before touching upon its production.

As doubtless most people are aware, engineering in every branch calls for the cutting of metals to very exact shapes. Further, for many purposes, such as gun barrels, armour plates, destroyer and seaplane crank-shafts, and a thousand and one finished steel parts, the metal to be cut is tough and hard. Hence it follows that the tools employed also must be hard and strong. This does not finish the problem, however. The hardest substances can be worn away in time by constant friction with comparatively soft bodies. The wear on stone steps by leather boots or even bare feet is a familiar example of this. We cannot afford, however, to neglect the time element, and the speed at which metal can be cut is the important factor. Further, for exact work on a big scale, such for instance as boring a heavy gun or turning a long length of shafting, it is necessary, for the sake of accuracy, to make a continuous finishing cut from end to end, without altering the tool and without sufficient wear on the edge of the tool to impair the exact diameter of the work. Another important point to be borne in mind is that the action of cutting or tearing the surface off a piece of metal generates heat, and the greater the speed and depth of the cut and feed the greater the heat.

Owing to the fine edge to which the tools must be ground and the fact that the tool never leaves the work, the heat affects the tool far more than the work. It follows therefore that good engineers' tools must combine a number of essential qualities, namely:

(1) Hardness to give a keen cutting edge.

(2) Strength to resist the enormous strain concentrated on the cutting edge and body of the tool.

(3) The property of remaining unaltered in hardness and strength at high temperatures.

(4) Uniformity in texture so that tools may be re-heated, re-made, and re-ground many times and still show the same characteristics.

(5) Uniformity as between one tool and another, so that identical results may be obtained in repetition work.

(6) Softness and ductility when heated to a suitable temperature, so that rolling and forging are possible without undue waste.

(7) The capability of being annealed or softened, so that complicated tools, such as twist drills, milling cutters, shell-boring tools, etc., may be manufactured while the steel is soft and may be hardened with the least possible distortion.

From this it will be realized that the problem of making a satisfactory high speed steel for engineers' tools is complex, since, for some purposes, one of the above qualities should predominate and, for others, a totally different steel may be preferable.

For many years tool steel, suitable for all the purposes to which the then existing light machines could be put, was obtained by hardening and tempering carbon steel, that is, steel the qualities of which are dependent mainly upon the amount of carbon they contain and upon the way in which the steel is hardened and tempered by heating and sudden cooling. The manufacture of such carbon steels suitable for the best tools was carried out in Sheffield with such skill that a product of the highest quality was produced and sold all over the world. Practical experience and scientific examination show that carbon steel of this quality can be obtained only by working with raw materials of the greatest purity. It is found that certain impurities, present even in minute quantities, affect the quality of the finished steel very materially.

The employment of tungsten in the manufacture of high speed steel, that is, steel capable of cutting at high speeds, may be traced to the discovery that certain impurities, so to speak, so far from having a deleterious action, vastly improved the quality of carbon steel. Broadly speaking steel, or rather iron containing varying quantities of carbon, can be improved in one or more characteristics by the addition of certain metals which in most cases have a higher melting point than iron. These include nickel, chromium, manganese, tungsten, molybdenum, cobalt, vanadium, uranium, and titanium. Each imparts to a greater or less degree tensile strength, toughness, hardness, or resistance to shock. What is equally important is that two or more of such metals in an alloy steel produce special results, while every combination again is varied by the amount of carbon present. From this it will be realized that the metallurgy of alloy steels covers a field capable of almost infinite variation, and the laboratories of the great steelmaking firms are constantly engaged in preparing and examining fresh combinations.

The special quality imparted to steel by tungsten is unusually interesting and valuable. Tungsten steels prepared with suitable admixture of carbon are not only extremely hard but in addition they maintain their hardness at high temperatures, even at an incipient red heat. Additional strength and toughness are imparted to tungsten steels by the inclusion of small quantities of other metals mentioned above, such as chromium and vanadium, while the quality of the finished tungsten steel may be impaired, or even destroyed altogether, by the presence of quite small quantities of certain other elements such as tin, sulphur, phosphorus, arsenic, manganese, or copper. It is important to remember this point in relation to the manufacture of tungsten, since a finished high speed steel as employed for making the best tools contains 18 to 20% tungsten. Hence it follows that unless the tungsten itself is practically free from such deleterious impurities, the finished steel will fail. Failure cannot be detected as a rule until an advanced stage in the manufacture or even after the tool has been put to work, so it is obvious that errors are very costly and wasteful and should be avoided in every possible way.

The first use of tungsten in steel was made by Mushet as long ago as 1857, and Samuel Osborn & Co., of Sheffield, for many years supplied Mushet steel containing a small percentage of tungsten, from 6 to 7 or 8%. The method of manufacture was to introduce a small quantity of tungsten ore into the steel crucible, together with a sufficient excess of carbon over and above that required in the finished steel, and in this way to reduce the ore from oxide to metal. By using carefully selected pure ore and by working under uniform conditions, Mushet steel was produced capable of working at speeds and under conditions unequalled by the very best carbon steels tempered with the utmost skill.

In the Paris Exhibition of 1900, the engineering world was introduced to tungsten steel which was shown working under conditions and at speeds which up to then were not generally known. This steel was treated by the Taylor-White process patented in the United States, but the patents were not upheld against action by a number of Sheffield steel makers, who were able to show that they had already made and sold quantities of tungsten steel which did not differ materially in composition and treatment from the Taylor-White process. The Sheffield steels were shown to be superior not only in quality, but in freedom from complicated heat treatment. The fact was that improved tungsten tool steels followed rapidly after Mushet steel, but their application was of necessity extremely limited, as the machines then in existence were not strong enough to withstand the increased strain of working at the full capacity of the new tool steels. The growth of the tungsten steel trade, or, as it was termed, the high speed steel trade, was dependent upon the gradual replacement of old machines by those of sufficient strength to utilize the high speed steel tools to advantage. In the meantime, as the manufacture of tungsten steel became an established industry, a demand arose for tungsten in a suitable condition for alloying directly and without the reduction of the tungsten ore in the steel crucibles.

Tungsten metal is not found as such in nature. To a very minute extent tungsten trioxide, or tungstic acid, as it is commonly called, is found, but, from a commercial and practical point of view, the source of tungsten is in minerals in which the tungsten trioxide is combined with the oxides of iron, manganese, or calcium. There are various modifications of the combination of tungsten, iron, and manganese oxides know as hubnerite, ferberite, etc., but in general these are classified together as wolfram. Calcium tungstate, the second main source of tungsten, is known as scheelite. Wolfram and scheelite are widely distributed over the globe, and as a rule they are found either in close proximity to, or actually mixed with, tin ore.

When found in lodes, or veins, these generally occur at the junction of the granite and slates, where granite has intruded through slaty rocks. Under these conditions cracks in the rock have filled with quartz containing the crystals of wolfram, scheelite, and tinstone. Unfortunately, the mineralization of these reefs is very patchy, and rich pockets may be adjacent to long stretches of barren quartz. The granite intrusions as a rule form lines of hills, or even mountains, where climatic changes over long periods have eroded the hill sides, and, in such countries, a certain amount of mineral is washed out and finds it way into the valleys. Unfortunately, however, wolfram and scheelite are by no means very stable bodies, and once removed from their quartz covering they break up into their constituent oxides, and the tungsten is washed away altogether. Any tinstone present, however, remains in the river flats, as tinstone is almost, if not quite, proof against destruction.

The main supplies of wolfram and scheelite now employed in the manufacture of tungsten metal powder and ferro-tungsten are found in the following countries: The United States, Bolivia, Peru, Argentine, Burma, Siam, China, Japan, Malaya, Australia, New Zealand, Portugal, Spain, England, South Africa. Small quantities are found in other countries, and it is by no means improbable that some of these will develop into important producers.

Wolfram, scheelite, and tinstone are all noticeable for their weight, that is, high specific gravity. The quartz and other rock which are mined or mixed with them are lighter and can be removed by washing after the whole has been crushed. In this way a concentrate of wolfram, scheelite, and tinstone, or of any combination of these, can be prepared. Such concentrates, if free from tinstone, are ready for the preparation of tungsten or ferro-tungsten. If tinstone is present in admixture with wolfram, advantage is taken of the fact that wolfram is slightly magnetic, while tinstone is not, and separation of the two can be effected by magnetic separators. Unfortunately, scheelite is non-magnetic, and if mixed with tinstone it can be separated only by chemical or smelting processes.

Turning again to the history of tungsten steel, the demand for metallic tungsten was met in the first instance by heating pure wolfram with carbon and a little additional iron to form an alloy of iron and tungsten containing 40, 50, or 60% tungsten. At that time the heat employed was that of coal, coke, or gas fires, and it was not practicable to melt ferro-tungsten with higher percentages of tungsten.

At the same time the high speed steel makers realized that they must have their tungsten as free as possible from deleterious impurities, or they could not successfully make alloy steels containing a high percentage of tungsten. The direct reduction of the wolfram ore was open to the disadvantage of including in the ferro-tungsten produced other elements whose oxides might be present in the wolfram, such as tin, copper, arsenic, sulphur, and phosphorus.

The problem of preparing pure tungsten thus became one of commercial importance, though initially the demand was too small to justify a separate establishment for the industry. It was attacked by some of the German chemico-metallurgical works, who, being equipped with complete investigation laboratories, well fitted works, and ample funds accruing from their other activities, were able to work out a suitable process and put it in operation.

Before long steel makers were offered tungsten powder containing 95 to 96% pure tungsten and practically free from deleterious impurities. They naturally welcomed this improved raw material for their high speed steel, and in time, as the result of competition, their demands for a still purer tungsten containing 96, and 97, or even 98% tungsten and under 0·5% carbon were satisfied.

The industry was not altogether overlooked in this country, and some abortive attempts were made to establish the manufacture of tungsten in England. Both in Sheffield and Glasgow small factories were started, but failed to produce tungsten commercially. From 1901 to 1905 I was associated with Dr. O. J. Steinhart in running a small factory in London, where some 300 tons of tungsten were produced. The metal made there proved to be of satisfactory quality, but the scale of manufacture, local conditions, and intermittent ore-supply made competition with the powerful German makers impossible. Other attempts to establish the industry were made by Messrs. Albright & Wilson, Blackwells, the Thermo-Electric Co., and by myself.

The Thermo-Electric Ore Reduction Co., of Luton, were attacking the problem of producing ferro-tungsten in electric furnaces just before the War, and it is interesting to note the hold that Germany had at that time on the industry. This company recently applied to the Courts for leave to rescind an agreement for the sale of their output to a German firm, who doubtless intended to resell at a substantial profit.

Unfortunately, however, the attempt to make tungsten in England was not sufficiently determined. The Tungsten & Rare Metals Company, with which I was associated in 1901, lost some £6,000, and I doubt whether, altogether, double this sum was spent in the attempt to establish an industry which, even before the War, had attained a turnover of more than £300,000 a year in this country.

Steel makers, who were the main consumers, have been blamed for allowing this state of affairs to exist, and I must admit candidly that at one time I shared this view. I realize now, however, that they had a vast task of their own in carrying out investigations for the improvement of their steels and in building up and maintaining their great export trade in high speed steels, which is based mainly on the high quality of their products. In respect of tungsten they adopted the so-called Free-Trade policy, and bought in the cheapest and most convenient market.

I can only add that I believe a modest outlay of some £25,000 to £30,000 between 1907 and 1914 would have established at any rate a small producing factory. This not only would have saved a lot of money since the War commenced, but a vast amount of anxiety for those who have produced our munitions. There was a very serious risk of an even greater shortage of munitions through lack of tungsten and high speed steel than was actually experienced, and it was only by the most strenuous efforts that this shortage was overcome.

I have dealt at great length with the use of tungsten for making high speed steel, as this is by far the largest industry involved. There are, of course, other uses of tungsten ; for instance, permanent magnets of the quality requisite for magnetos and telephones are made of tungsten steel. Tungsten filament lamps are highly important, as they consume a minimum of electricity and consequently coal. It is probable that extended use will be made of tungsten in various directions once the insistent demand ceases for munitions purposes.

Thanks to our Navy, Germany has suffered from a shortage of tungsten almost amounting to a famine, and this must have caused no little difficulty.

A few figures may be of interest. The world's consumption of tungsten ores rose steadily from 4,000 tons in 1906 to 10,000 tons in 1913. During this period the British Empire produced approximately half, and in fact possessed a controlling interest. Since the War the output of ore has risen to close upon 20,000 tons per annum, and the United States has jumped into the position of being the largest producer, having increased the output from 1,400 tons in 1913 to close on 7,000 tons in 1916, while the Empire production for 1916 was under 6,000 tons. The increased production within the British Empire was no small achievement in itself under war conditions. The most promising field was Burma where, however, the production was mainly in the hands of natives and Chinese. Further, the discovery of wolfram in Burma was of comparatively recent date, and transport facilities, machinery, and the thousand and one requisites for mining development had not yet been introduced. At the request of the Government of India a number of big Indian merchant firms embarked on the hazardous enterprise of mining for wolfram. Concessions were taken up and explored, native and Chinese-owned mines were purchased and developed at high cost. Thanks to these patriotic efforts and the judicious administration of the Indian Government officers, Burma has responded nobly. I fear, however, that large sums have been spent in many cases from which no return is likely. Australia, New Zealand, and Cornwall have contributed their quota, and what is equally important, the wolfram and scheelite mines of the Empire have been rescued from the clutches of Germany whose fingers were already reaching out to control the industry. I need hardly dwell on the vital necessity of keeping the British Empire sources of supply of this important raw material in the hands of British-born citizens. I hope it is too obvious to need emphasis or agitation.

In 1914, tungsten metal was produced, as I have said, almost entirely in Germany. The United States was partly self-supporting, and France was attempting to compete with ferro-tungsten made in electric furnaces supplied from hydro-electric installations.

Prior to the declaration of War, the price of tungsten in Sheffield had been falling for some months, and the tendency to fall had resulted in buyers holding back, so that stocks were abnormally low. How far this was manipulated I cannot say. In August, 1914, high speed steel makers realized that there was in this country barely four months' stock of tungsten for the normal output of high speed steel, and it was evident that the demand must increase rapidly. The technical advisers to the Admiralty and Board of Trade, Lord Moulton and Sir Boverton Redwood, made inquiries on the subject and got in touch with Mr. Arthur Balfour and Mr. A. J. Hobson, two prominent members of the Sheffield high speed steel industry. The Committee of High Speed Steel Makers, already in existence, was called together, and, after investigating the relative merits of pure tungsten powder and ferro-tungsten, decided that the high speed steel industry could only produce steel of the requisite quality by employing tungsten metal powder equal in purity to that previously supplied by Germany.

I was asked to meet the Committee, and, in view of the fact that I had been associated with the only factory which had ever produced tungsten powder on a commercial scale of output in England, it was decided to enter into an agreement whereby I undertook to design, erect, and put in operation, a factory capable of producing tungsten powder, equal in quality to that supplied by Germany and suitable for the manufacture of high speed steel.

Preliminary arrangements were made as quickly as possible. It was decided to reject an offer of financial assistance made by the Government, and every established high speed steel maker was given an opportunity of subscribing towards the capital required. Firms which collectively had used some 80% of the tungsten consumed in this country before the War, joined in the enterprise, and a company entitled High Speed Steel Alloys, Limited, was formed. By the end of the year 1914 a site for the factory in Widnes had been secured and the first contracts for buildings had been placed. In July, 1915, the factory commenced delivering tungsten and has continued to do so without intermission ever since.

In the meantime a number of private firms had decided to embark on the manufacture of tungsten and ferro-tungsten. These included the Thermo-Electric Company, Blackwells, the Continuous Reaction Company, British Thermit Company, Newcastle Alloys Company, Tyneside Alloys, Albright & Wilson, and one or two others.

While the various factories were completing their preparations and starting production, the question of ore supplies became prominent. The Government entrusted Vice-Admiral Sir Edmund Slade with the control of the industry. He arranged to secure the ore supply available from the whole British Empire, at a uniform price. From a comparatively early date prices for ore, tungsten, and high speed steel were controlled in such a way that the British steel makers, and in reality the Government, secured their supplies of tungsten at a figure which has always been far below that ruling in other countries. By this arrangement a large sum of money, probably over £2,000,000, was saved by this country. Eventually the control of wolfram and tungsten was transferred to the Non-Ferrous Metals Department of the Ministry of Munitions.

I will now deal with the manufacture of tungsten. As I have explained, there are a number of makers each working his own special process of which naturally I cannot give you any details. I can only tell you about the method of manufacture installed by me at Widnes. The factory is served by railway sidings and the concentrates are unloaded, weighed, and sampled in what we term the mill. This is a steel building in which the concentrates are elevated and then pass by gravity through grinding mills and, when required, magnetic separators. The finely ground pure ore is trucked to Department "A" where it is mixed with soda, and thence to Department "B" where the mixture is heated in special furnaces to a bright red heat. The furnace product is drawn out in a molten state, allowed to cool, crushed in Department "C," and taken to Department "D," where it is boiled with water. The result of heating with soda is to convert all the tungstic acid in the ore into tungstate of soda, a soluble material, while oxides of iron, manganese, lime, etc., remain insoluble. In Department "D" the soluble sodium tungstate is filtered away from the iron, manganese, etc.

The next operation, conducted in Department "E," is to treat the sodium tungstate with hydrochloric acid and reverse the previous operation by producing insoluble tungstic acid and soluble sodium chloride (common salt). The insoluble tungstic acid is filtered from the solution of salt and dried in Department "F." Up to this point the whole process aims at preparing pure tungstic acid (trioxide of tungsten or WO_3). This is then taken to Department "G," and reduced to metal in a special furnace. The metal thus obtained is in the form of powder, as the temperature of the furnace is not high enough to melt tungsten. It is washed and dried in Department "H" before packing. The above outline of the process naturally is sketchy, and perhaps hardly conveys the precautions required for producing metal of the necessary quality. Every intermediate product is sampled and assayed, some 80 to 100 assays being carried out daily. Exact weights are taken and losses in process are checked, examined into, and have been eliminated to a large extent. Special departments have been erected for treating low-grade and mixed tin-scheelite concentrates.

The whole factory is really an enlarged laboratory. The buildings cover an area of over 70,000 sq. ft., and they are all of a permanent nature, so far as a chemical factory can be permanent. The metal produced averages 98½% pure tungsten, which is fully 1% better than the best German makers used to send to Sheffield.

I have already explained that I cannot compare the Widnes factory with those of other makers, but I can give you a brief outline of their processes. Three other firms make tungsten powder probably on similar lines to those employed at Widnes. Two factories produce ferro-tungsten by heating pure wolfram and carbon in an electric furnace. The melted product is broken up and ground to powder. Three factories produce ferro-tungsten by alumino-thermic methods, that is, by mixing the pure ore with powdered aluminium which, combining with the oxygen in the oxides of tungsten, iron, etc., generates great heat and produces molten ferro-tungsten and a slag which, being lighter, floats on the surface. The ferro-tungsten is broken up and ground to powder.

I must say a few words on the vexed question of the relative merits of ferro-tungsten and tungsten powder. For high speed steel making, experience has shown that sulphur, phosphorus, manganese, tin, arsenic, copper, and lime must be kept within very narrow limits. All these are to be found to a greater or less extent in wolfram and, in the direct reduction to ferro-tungsten, are liable to be retained. By employing carefully selected ore and taking proper precautions in manufacture, a ferro-tungsten can be produced, which complies with a reasonable specification, and in this case it can be employed successfully for making high speed steel. For steels containing lower percentages of tungsten, the permissible impurities may be higher, and ferro-tungsten of suitable purity has some advantage in melting at a lower temperature. It is preferred by some steel makers for use in electric furnaces, though others find tungsten metal powder quite as satisfactory when employing the electric process. On the other hand, tungsten powder can be produced of uniformly high grade from ores containing all manner of impurities. The difference in assay of tungsten powder between one parcel and another is negligible, which is a great convenience to the steel makers. I may add that the majority of high speed steel makers decided in 1914 that tungsten powder was essential, and I believe that they have not had reason to change their views.

I have attempted to cover a great deal of ground within the limit of time at my disposal, and I fear that the dry bones of such a subject make a poor repast, even in these days of rationing. I may say, however, with some pride, which I hope is pardonable, that an industry of no small importance has been established here under very difficult conditions, and I am of opinion that the industry can be maintained permanently, on economic, quite apart from national, grounds, if it is given a fair chance. It cannot, however, fight with a halter round its neck, and the gravest danger it has to face, in view of the inevitable post-war competition, is financial weakness, due largely to excess profits taxation and the stock valuation policy, together with the failure of the Government to recognize the necessity of drastic depreciation of buildings, plant, and machinery for renewal purposes in metallurgical factories.

Our German rivals can afford to scrap and do scrap their plants in five years. Ours are supposed to last 15 to 20 years. I can only say that no twenty-year-old factory will be able to compete with one that has been rebuilt three or four times in the same period.

In conclusion, I would point out that the tungsten industry is of interest in relation to the great Imperial problems which have to be faced by the British Empire. There exists within the Empire, and mainly in our overseas dominions, an ample supply of raw material, from which to manufacture tungsten sufficient for the Empire's home and export requirements of high speed steel. The manufacture of the steel requires skill, experience, and costly plant, all of which exist in this country. The manufacture of tungsten and ferro-tungsten, as I have shown, also has been perfected in England. An ideal combination can be effected by a policy which (*a*) encourages production of wolfram and scheelite in the overseas dominions at the lowest possible cost; (*b*) retains the minerals for smelting into tungsten in England; and (*c*) thereby secures an ample supply of tungsten for consumption by British high speed steel makers, who thus can sell the finished steel in the markets of the world, at competitive prices.

THE TECHNIQUE OF DIAMOND-DRILLING

By J. A. MAC VICAR.

We print herewith a paper read before the Cornish Institute of Engineers last month. It forms a fitting supplement to the author's article published in the Magazine for October, 1918.

DURING the past two years, diamond-drilling operations have been continuously in progress in Cornwall, and that this method of mining development and prospecting has been a success in every way is beyond question. It is opportune, therefore, to look into the history and utility of the diamond-drill, and discuss its application from a general point of view.

It is not generally known that recent discoveries show that a drill having an annular face, probably of bronze, and employing corundum or some similar material, was used by the ancient Egyptians some 3,000 years ago. Statues and figures, having holes made by an instrument of this character have been discovered, though it is improbable that such instruments were used for mining purposes.

In 1862, a French engineer, Jean Rudolphe Leschot, of Paris, secured French and British patents on a diamond-drilling apparatus, which, so far as is known, was the first implement of this sort to receive official notice. This tool was intended for prospecting and mining work, and the following description is taken from the patent specifications:

"This invention consists in the construction and employment of tubular tools armed with diamond cutters to which rotary action and advancing motions are communicated. The tools consist of metal tubes with a ring of iron or steel at the working end, into which diamond cutters are fitted. The tube is connected to a shaft by a bayonet or screw joint. On rotary and advancing motions being communicated to it, it bores or cuts a circular aperture in the rock, stone, or other material acted on, and receives within it a core or bar of such material which is afterwards removed. A pipe may be connected to the tube for forcing in water to remove the detritus.

"The apparatus for working the tool is mounted upon a carriage on wheels, or on a bed, supporting standards in which bearings are formed for receiving the shaft to which the tool is fitted. Rotary motion is communicated to the shaft through a toothed wheel gearing into a pinion on the driving shaft, which has motion communicated to it from a crank, or pulley, or otherwise. The advancing motion is communicated through a wheel on the crank-shaft, communicating motion to another wheel on the tool shaft through the agency of an intermediate wheel; one end of the tool shaft is threaded, so that while it revolves, the screw at the same time imparts a forward motion to it. For convenience, the carriage may be run on rails, or may be secured to them by grippers fixed to the carriage.

"According to the work it is to be put to, the boring tool may be single or multiple; that is to say, any number may be fitted on one frame, being so arranged as to work at all angles, and in all directions; parallel, convergent, or divergent. Motion may be communicated by hand, steam, or other power."

The sketches in these specifications indicate that holes of great depth and of large diameter were contemplated for this tool, as well as smaller diameters and shallower depths.

The first American inventors to make use of the diamond-drilling principle were M. C. Bullock, later president of the M. C. Bullock Manufacturing Co., and Albert Ball, chief mechanical engineer of the Sullivan Machine Company, both of whom did work along this line in the late sixties and the early seventies. Mr. Bullock developed his drills principally for mineral prospecting, while Mr. Ball worked out designs for quarry drilling, and, for fifteen years or more, the Sullivan diamond-channellers and gadders were the principal means employed for excavating marble in the New England quarries. With these tools, holes were bored parallel to each other at close intervals and the blocks of marble wedged off without blasting. For this purpose the channellers and gadders were mounted on trucks and ran on tracks, being the precursors of the modern machines of this name. The utility of the diamond-drill was being gradually recognized, and coming more and more to the front as a most efficient and economical prospecting medium, and the increasing demand for these machines led to a supply of improved instruments. The Diamond Prospecting Co. was amalgamated with the Sullivan Machine Co., which took the name of the Sullivan Machinery Company. While the M. C. Bullock Company were devoting all their attention to the screw-feed type of diamond-drill, the Sullivan Machinery Company, digging deeper into the matter, evolved the hydraulic type of feed, in addition to the screw. In the year 1901, on the demise of Mr. Bullock, all of the Bullock Co.'s diamond-drill interests were taken over by the Sullivan Machinery Company, and this make of diamond-drill may now be said to be the world's standard.

Mechanically, the diamond - drill is a very simple instrument, easy to understand, and simple in operation. The drill itself consists of a line of hollow rods, connected by screw joints in 5 or 10 ft. sections. At the lower, or "business" end of the rods, the diamond bit, or crown, is attached. This is an annular ring of mild steel in which the diamonds are set by the caulking method, that is, a hole is bored in the metal of the bit, the diamond placed therein and firmly caulked. As a general rule, there are eight stones, or diamonds, to the bit, and these are so arranged that while the eight are cutting on the face of the bit, four of them cut the outside clearance and the other four the inside clearance, which means that two sides of each stone are always at work. The line of drill rods carrying the bit are rotated, generally through shafting and gears, and advancing motion is imparted by the same action, by a differential gearing in the case of the screw-feed type, and in the hydraulic type of feed by the pump through a hydraulic cylinder of suitable dimensions. The feed or advancing motion when imparted through the hydraulic cylinder is very flexible, and is under the direct control of the operator; it can be instantly adjusted by him to cover the requirements of any class of material in which the bit may be boring; and by the simple opening or closing of a pet-cock or valve he can adjust his feed to the rate of one foot per hour or one foot per minute as the exigencies of the case may require.

Generally speaking, there are three positions in boring: vertically upwards, vertically downwards, and horizontal; though as a matter of fact holes can be bored at any angle from vertically upwards to vertically downwards. By far the largest amount of diamond-drilling is down drilling from the surface, and the generality of the work ranges from 90° from the horizontal to 45° from the horizontal. The angle which the hole takes is governed, of course, by the dip of the stratum sought, and the depth at which it is desired to penetrate it. As it is my intention to look at diamond-drilling as closely as possible from a practical standpoint, I will start with surface drilling and its peculiarities.

The depths to which it is desired to bore are the deciding factors in the selection of the type of drill to purchase for the work. It will be understood that the Sullivan Machinery Company's drills are the ones referred to in this paper, for the simple reason that, whereas other types of drills are spoken of as having capacity to drill to great depths, only the Sullivan diamond-drill has yet started a bore at surface and carried it continuously to a depth of close to seven thousand feet.

When, therefore, the location of the bore has been decided on, also the depth to which it is desired to carry it, the position is prepared for the drill, and, unless in the case of holes that are to attain a depth of 6,000 or 7,000 ft., the process is generally along the following lines. Four sills of 8 in. by 8 in. by 16 ft. are prepared as a foundation. These are laid and levelled, and the drill frame bolted to them, generally by lag screws. A derrick, or tripod, having legs 35 ft. long and of suitable dimensions to withstand the hoisting strains, is then set up over the drill, the sheave wheel or pulley hung thereon and the whole aligned so that the cable will pull in direct line with the bore. This portion of the erection of the outfit needs care, as the truer the alignment between the cable and the bore-hole, the less friction there is during the hoisting operations; there will also be no tendency for the rods to become bent in pulling. The drilling head, of course, must be set to the exact angle at which the hole is to be bored before finally aligning the hoisting cable. Everything being in readiness, the hole is then started, and as there is always some soil, it is started with a mud-bit. This is in reality an auger bit which attaches to the lower end of the rods, and is rotated through them by the engine, and advanced in exactly the same method as the diamond-bit is advanced. This operation is continued as far as possible, but when the hole thus made shows a tendency to close in, a pipe, known as the "sand, or stand-pipe" is inserted, either by withdrawing the mud-bit, or being slipped over the rods and mud-bit, as this latter must be of such diameter as to permit of its being readily withdrawn through the pipe. The pipe is then washed and turned as it is being driven to bed-rock. It must be stated that the bottom end of the pipe is fitted with a steel shoe, and when bed-rock is reached the pipe is driven down so that this shoe penetrates the rock and makes a mud-tight joint, thus shutting the soil completely off from the bore-hole. If the soil is homogeneous the piping operation is simple and easy of accomplishment, but when a pipe must be driven through boulder-clay, then the operation becomes a little difficult. When a boulder is encountered, it may be possible to chop through it with one of the chopping bits. These are steel bits, similar in shape to the regular rock-drill bit. With one of these connected to the lower end of the rods, the boulder, unless it is too large, is chopped up and washed away. If, however, the boulder is large and refractory, then it becomes necessary to blast it away, or at least to blast a hole through it. This is done by chopping a little way into the boulder, and putting a charge of dynamite into it, the charge being from one to three sticks of 40% dynamite. The charge is fired electrically. After the hole has been chopped into the boulder, the dynamite, with wires attached, is lowered into place in the hole, the pipe is then withdrawn a few feet to protect it from the explosion, and the charge fired. The pipe is then allowed to fall back as far as it will go, the chopping-bit again inserted, and the ground chopped and washed until the pipe reaches bed-rock. The hole is then washed clean, the diamond core-bit inserted, and boring operations commenced.

It will generally be found that the rock formation directly under the soil is more or less porous, scaly, or shattered, so much so, that it will not stand up, and pieces continuously break off and fall into the hole. Should drilling be continued under these conditions, pieces of this caving material would fall into the hole and wedge the rods, making it impossible to withdraw them. It may be safely said that the majority of diamond-bits that have been lost in bore-holes, have been lost from this cause. It becomes necessary, therefore, to shut off this caving material, and to do this the diamonds are set into a bit of large enough diameter to allow of the insertion of a casing-pipe. These are termed casing-bits, and the pipe is called casing. This is a special pipe made for the purpose. They are so made that the joints screw together to make a flush joint and leave a smooth, parallel-walled case through which the diamonds may be handled without any danger of breakage such as would certainly occur were the ordinary pipe, with its irregular seams and protruding joints, used. When the loose portion of the hole has thus been cased off, boring operations are recommenced, and the hole carried to completion. This, of course, is premising that the ground is solid, and the hole remains open after boring. At times, however, more especially in the metalliferous areas, the bore-holes have a decided tendency to cave, and this is more especially the case where the ground being bored has been subjected to structural movement, and invariably the case where the movement has been of such a nature as to have formed a brecciated zone. If these zones are encountered close to the surface, it is a simple matter to case then, but if, after having cased one part of the hole, one runs into another caving portion farther down, then to ream and case this second part might make the cost of the boring prohibitive. Cementation is then resorted to. Thus it will be seen that there are two distinct methods of handling caving or loose material in a bore-hole. First, the casing method which has just been described, and second the cementation method, in which the cement is pumped into the bore and allowed to set, then bored out as though it were the solid rock.

Generally speaking, the method to employ depends entirely upon the nature of the ground being bored. Sometimes, in the slates, shales, sandstones, and the more homogeneous of the limestones, it may be as economical to ream and case as it would be to cement; and, as regards time, it might even be the more economical method of the two. The closing of the cave must thus depend on the judgment of the man in charge, but in the harder formations, the cementation method is the logical method, as the reaming of such rocks as granites, diorites, quartzites, etc., will mean that the item of carbon wear alone will prohibit its adoption, and, as to continue the bore the loose ground must be shut off, then it only remains to cement. It may be said in passing, that cement is pumped into the bore-hole pure, without the admixture of any other material whatever, excepting such cases as shall be noted later. In the cementation of a bore-hole, if the bore is shallow, the cement may be poured into it and then rammed with the rods, the lower end of which must be closed. In no case should cement be poured in and allowed to set, as there will always be an air-lock that will hold the cement up in the hole, and in nine cases out of ten this lock will occur above the point that it is desired to cement. By the use of the rods and the pump, the cement is introduced into the hole where it is needed. The length of time required for the cement to set will vary. In a dry hole, 72 hours will be found ample, and a wet hole will require twice as much time. It can confidently be said that if the cement be allowed to set firmly enough to make a core when being bored the results will be 100% efficient; if it is bored out while still partly gelatinous, it will, if the bore continues for any time, be 100% inefficient.

In boring one sometimes taps a head of water which, as it travels through the bore-hole carries silt and pieces with it to such an extent that it becomes necessary to shut off the water, or it may be that below the water fissure a caving zone is met with that must be shut off. This will require cementing against the head of water. The process is as follows: The top of the casing-pipe is fitted with a valve; the pump discharge is connected to this valve and the cement pumped in until the pressure becomes too great for the pump to work against; the valve is then closed, the wheel or handle removed in order to make it fool-proof, and the cement given not less than a week in which to set. It is obvious that in this case the entire hole will have to be re-bored, but cement drills very rapidly. Cementation against a head of water is exceptional, but I have had such and overcame the trouble as has been outlined. It will be further noted that the cementation of a bore-hole under this condition is almost identical with that employed for the sinking of shafts through loose ground; the exception being that in the cementation of bore-holes, the regulation pump is used. This is generally of the boiler-feed type, and as a rule it is a duplex, the dimensions of which are 6 by 4 by 6 in. All that has been said applies to bores having an angle down from the horizontal. For horizontal holes, or those having an angle up from the horizontal, a casing pipe would first have to be cemented in, and the same process as for cementing against a head of water employed; and this, of course, would mean the filling of the entire bore.

What has already been said covers, generally speaking, the entire operation of the diamond-drill in the actual boring of a hole. In some cases, however, there arises the necessity for boring a series of holes from the one position. In other words, it is required to "fan" a series of holes. It may be said that the success of this method depends entirely on having sufficient room in which to work; that is, there must be ample space in the line of each projected bore in which to handle the rods. On surface this is easy enough to accomplish unless the holes have a lesser angle than 45° from the horizontal. The greater the angle from the horizontal the greater the facilities. Still, in every case the initial operation will depend on the nature of the surface. It must be borne in mind that each hole must have the soil completely shut off; the flatter the angle, the greater the amount of pipe required; and the longer the pipe is, the greater is the tendency of the bore to be deflected at the start. All piping at any angle has a tendency to deviate from the course while being driven. Pipe having a lesser angle than 70° from the horizontal will invariably turn up in the process of getting it to bed-rock. If, therefore, a series of bores is projected from one location, and the overburden is not too extensive, it will be to advantage to sink a pit to bed-rock and set up in the pit; from the item of cost, however, this can only be done where the amount of overburden, or soil, is a negligible factor; in other cases, the cost of sinking the pit and keeping it free from water will place the costs of the work on the prohibitive side. And it may be said that, as a general rule, the fanning of fairly flat holes from the surface is poor practice, as it will be found more economical to locate the holes in a series of places, as everything possible from a fan location can be accomplished in this way. If it were possible to radiate from one drill-hole the problem would be solved, but this is out of the question as the uncertainty is too great, accompanied as it must be by the additional frictional resistances on the line of drill rods and the tendency this would have to twist them off while boring was in progress. In South Africa, deflections of this kind have been carried out, but only in the very deep bores, and these were exceptional cases. The fanning of drill holes, therefore, cannot be said to be either an efficient or economical proceeding when carried on from the surface; but underground conditions sometimes call for drilling of this kind, and as the facilities are always greater it only remains to set up so that there will always be plenty of room behind the drill in the line of each bore. It would seem, therefore, that where a series of holes is proposed from the surface it is more economical to get as nearly above the desired points as possible instead of going to bed-rock for the purpose of fanning; whereas, in underground practice, it is quite possible that one location and a fan would be the best.

It often occurs that while one is aware of a workable area at a certain place, one has no data as to the most suitable place in which to sink a shaft, and some work done with the diamond-drill for this purpose will be found to be the most profitable operation imaginable. In one case a shaft had been sunk in such a position that both the haulage and drainage are away from the shaft, and it is needless to remark that the opposite is the proper practice. A series of only three holes here would have defined an anticilinal fold, and the selection for the right position for the shaft would have been quite a simple matter. Results obtained in a case of this kind would have paid the cost of the drilling equipment and diamonds many times over even had it never again been used.

I think I am correct in saying that, with the exception of Cornwall, all the large mining centres of the world make use of the diamond-drill in underground development. The drills are used to prove ore in the stopes; to test the continuity of the ore-body in depth; to analyse faulted zones; and as a general controller of the direction of development. The out-of-reach portions of the property are brought within reach and annotated on the plans as workable or unworkable, because by the use of the diamond-drill their mineral content is known. Rule of thumb is thus abolished and accurate and reliable data are established as a working basis. Without the diamond-drill the lodes or ore-bodies must be developed by the haphazard method of following where they lead, irrespective of values; and if extensive barren areas are met with in the ore-body this section is very apt to be abandoned even though there be pay ground beyond. This method of following the lode with the shaft also gives rise to the most crooked and inefficient openings that it is possible to have. The very nature of such openings must restrict the output, while the twists and bends imperatively restrict it in the lessening of the rope speed while winding. When direction of development is controlled by diamond-drilling it is possible to so arrange matters in the shaft, at the underground stations, and in the surface equipment for a maximum output at a minimum of operating costs. Further, it is not necessary to continue a stope beyond its known pay areas, neither is it necessary to drift or cross-cut into an unpayable section of the mine; and in this respect it may be said that some of the most valuable work done by the diamond-drill in mining is in the elimination of barren areas. In other words, the negative results obtained from the use of the diamond-drill are very apt to be more valuable than the positive. All arguments against drilling fall rather flat when they come down to hard facts. There is no condition that cannot be improved by diamond-drilling.

Diamond-drilling does not end with mineral prospecting. Of late years diamond-drills have been used very extensively in the testing of foundations for dam sities; aqueduct courses are also defined by diamond-drilling, as are also the foundations for bridge piers. Some [illegible] been done in the latter case, especially where the bridge crosses a wide and turbulent river. It may also be of interest to state that, formerly, bridge pier foundation sites were tested by percussion or churn drilling, and the results in several cases have been disastrous. There is a great difference between the detritus from the percussion method and the cores from the diamond-drilling method. In the case of the churn, or percussion drill, one has a bunch of material of which it may be possible to determine the nature; in the case of the diamond-drill the core speaks for itself. In civil engineering projects of this nature, the success of the diamond-drill has been every whit as great as in the prospecting of mineral areas.

As was remarked in the early part of this paper, the diamond-drill is a very simple instrument. It is at the same time just as much an instrument of precision as is the theodolite, and even as the theodolite requires efficient and experienced handling so also does the diamond-drill. Carbons, at the present time, cost from £15 to £17 per carat. Bortz can be obtained far cheaper, but experience has proved that only the very best grade of carbon will give complete satisfaction under all conditions. Great care and wide experience in the handling of carbon for drilling purposes are the necessary attributes when it comes to selecting carbon, and the proper selection of the carbon is of primary importance in the minimizing of the costs. Having purchased the carbons, we then have the work of setting them into the bits, and efficiency in this line is only acquired by care and practice. In addition to setting the carbon into the crowns so as to be as nearly as possible part of the crown itself, an accurate gauge must be maintained throughout. The gauge at which the bore is started must also be the gauge when the bore finishes; unless in the case of the very deep bores where we start with a large bit and finish with a smaller. But where, as in Cornish practice, the original size is maintained throughout, the setting of the stones to an accurate gauge cannot be too heavily stressed.

The running, or operating of the drilling machine is also a very simple operation, but the knowledge of what the bit is doing under varying conditions while the machine is running is what constitutes the efficient operator of the diamond drill; and this also is only acquired by practice and intelligent interest in the work.

As has already been said, in difficult ground, that is, ground that caves, or is too soft to re- [illegible] comes necessary either to case the hole with pipe or to cement it. As has been explained, the casing of the hole means that it must be reamed out to a larger diameter, and this may mean several hundred feet of extra boring and the consequent carbon losses. Modern practice is, therefore, all in favour of the cementation process as being the most economical. As a general rule, bore-holes only give trouble in certain zones, though these particular zones may cover from 10 to 100 ft. of the bore. When these are encountered at any distance from the collar, it is quite obvious that the reaming process will be slow. If the material penetrated has been hard, then the carbon costs for the reaming will closely approximate the boring costs, even though the amount of material to be cut in the reaming is but a portion of that which was cut by the boring proper. This is occasioned by the fact that the reamer bit has not a completely solid bottom on which to bear while cutting; and this condition gives rise to considerable vibration which, irrespective of the pressure put on the bit, will permit it to dance in the hole and cause a hammering process to take place which is destructive of carbon. Thus it will be found in about nine cases out of ten that the cementation process is the logical method to adopt. In the majority of cases it will be found that the cement, when pumped into the bore and allowed to set properly, will overcome the trouble. It must be borne in mind that the cement should be hard enough to core before being bored out. In some cases, however, it is quite a problem to get the cement to that part of the bore where it is needed, as the following instances will illustrate.

The writer had the opportunity of demonstrating the utility of the diamond-drill in the boring of the loose material of the Miami mine in Arizona. The success of the drilling in this instance depended on one's ability to cement, and it was found that the method adopted in one hole did not apply to all. In order to give some idea of the ground being bored, it may be said that one round blasted in the face of the cross-cut in which the drill was working took six weeks to tram out, working three shifts per day. The hole in this cross-cut went to a vertical depth of 300 ft., and it took three months to complete, as the cemented portions of the hole began to break down as soon as the bit had advanced 20 ft. below them, so that the hole had to be recemented on an average of every 20 ft. On this particular hole, it was found that the rods could not be worked to the bottom and kept open long enough to get the pump to start the cement through them, the pressure of the material in the hole closing the vent in the rods even against the pressure of the pump. The opening in the end of the rods was, therefore, closed, and a series of $\frac{1}{4}$ in. holes drilled through the bottom rod for a distance of 6 ft. from the end. This was worked down, and the cement pumped through. In every instance it was found that at least half of the holes had been closed before the rods got to the bottom. This hole was more or less in the nature of an experiment, and it showed that the costs, if the work continued thus, would be rather high. It was proved, however, that the ground could be drilled if the lost time, while waiting for the cement to set, could be eliminated. It was therefore decided to carry on two locations, drill one as far as possible, cement, and then move the machine to the next; drill at this as far as possible, then cement and move back to the first, where the cement would be bored out, the hole advanced as far as possible, and recemented. This method was of great advantage, as it gave the cement in each instance ample time to set solidly. In this manner the work proceeded at an over-all cost of about 25s. per foot. It can be readily imagined that the percentage of core from ground of this type was rather low. In order to obtain as accurate a sample as possible, a cross-piece was fitted on to the collar of the pipe, and two jute bags attached thereto into which all the water from the drill-hole passed, and through which nothing but the water escaped. Several tests of the cores obtained with the sludge gave as mineral content of the core 1·28%, and of the sludge 1·29%, thus proving conclusively that the sampling of the ground was efficient.

In other holes bored in the same mine cementation was successfully carried out by putting the cement into paper cartridges, dropping them into the hole and ramming them. It is my opinion that where this process was possible it was even more efficient than the pumping method, for the simple reason that the ramming seemed to drive the cement farther into the surrounding material than was possible with the light type of pump.

In the same mining district, Globe, Arizona, the writer bored a hole underground, into which about four tons of sand, cement, chopped hay, etc., was placed without any results, showing that the cavity, vugh, or more probably, underground stream, could not be stopped by these methods. Wooden pins were made, similar to those used for pinning timber together, and dropped into the hole. These were from nine to fifteen inches long and about one inch diameter; 165 of these were dropped in, and formed, as it was hoped they would, a crib work. Alternate layers of sawdust, chopped hay, and sand were then passed into the hole, until it was found that the pins had held. Dry cement was then mixed with sawdust and slowly washed down. As this was found to be holding, it was lightly rammed at first, then as the cement was found to be filling the hole it was rammed as tightly as possible, finishing with a further mixture of sawdust and cement. When it was bored out, we had a core of concrete reinforced with wood. In several instances the writer has used this combination of sawdust and cement to great advantage, the sawdust seeming to act as a retarding agent, or in other words, making the cement so sluggish that it could not flow freely and gave the cement time to set instead of being carried away. The foregoing may give the impression that to drill in this way would give rise to prohibitive costs, so that it may be well to state that the last two methods were adopted while the work was being carried out by the Sullivan Machinery Company on a contract basis.

A condition often arises, more especially when boring the coal measures, where the first hundred feet or so of the hole has been cased, and lower down a caving formation is encountered where it is deemed more advisable to case than to cement. (I might here remark that my belief is that if one had a pump capable of forcing the cement into the hole at a pressure of from 300 to 500 lb. per sq. in., the necessity for casing would never arise. It is obvious, however, that it is not possible to include a pump of this kind in the equipment of a diamond-drill, so that the regulation pump has to suffice). In deciding to case, it is obvious that one cannot pull out the casing that is already in the hole, as to do so would probably mean the loss of the bore from the caving material already cased off, so that one has to use an expanding reamer. This is an instrument designed and manufactured by the Sullivan Machinery Company for cases of this kind. It consists of a reamer bit, made in two pieces, in which the diamonds are set as in usual practice. This is attached to the rods on a special rod, which consists of a cylinder and plunger. This instrument is lowered into the hole through the casing already there. It is then stopped, and the casing pulled back a few inches to uncover the collar of the hole. The pump is then started, and this forces the plunger down into the cylinder to which the casing bit is attached, expanding it to the size of the hole required for the casing. The reaming is then proceeded with. When it is necessary to withdraw this bit, it is drawn sharply against the bottom of the casing pipe, which action breaks a wooden pin, allowing the bit to fall in so that it can be readily withdrawn through the casing pipe. The pipe is then lowered to place, the bore washed out, and drilling proceeded with.

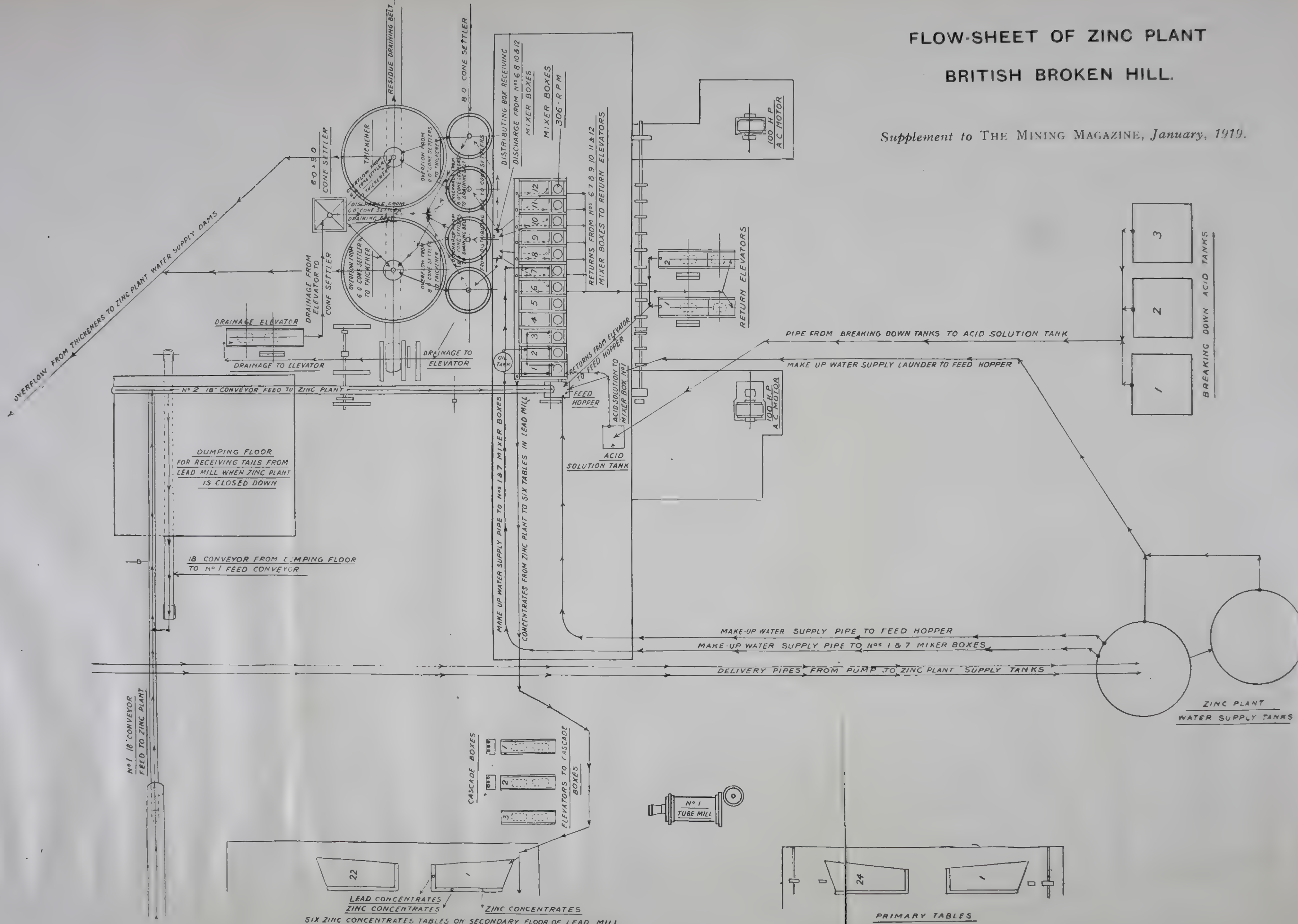
There is another instrument that is being universally used in boring for coal, and in a special form it is also adapted to boring in the metalliferous formations; this is a double-tube core barrel. This instrument was designed to protect the fragile section of the coal as cored (2 in. diameter) from the mechanical action of the wash water. It consists of two tubes, an inner and an outer; the inner tube, which forms the receptacle for the core, is hung on a ball-bearing and remains approximately stationary, while the outer tube carrying the bit revolves around it. The water from the pump is passed between the two tubes, and the cores are thus protected from its action. The use of this instrument has standardized the boring of the coal areas of Canada, the United States, and Australia, to such an extent that the 2 in. diameter core is almost universal, and has been found amply sufficient for all needed purposes. There are still, however, places where it is deemed necessary to use both the percussion and diamond-drills in the boring of the coal areas, and in these cases the holes are started at from 18 to 16 in. diameter. The reasons are a little hard to understand when one knows that successful coal-boring has been accomplished in similar areas with a hole not greater than 8 in. diameter, and I have to remark that to pipe a hole having a diameter of 18 in. to any depth would constitute quite an item as regards costs of pipe alone. In several instances, coal prospecting has been carried out by the percussion method entirely, and in some cases disastrously, as far as finances were concerned, as, on results from this type of drill in the States, shafts have been sunk only to discover that the coal seam uncovered by the percussion drill was nothing other than a bed of highly bituminous shale.

As in all other parts of the world, the diamond-drill in Cornwall has been an undoubted success. The puzzling part of the proposition lies in the fact that it is not in more general use. A campaign with the diamond-drill means the elimination of chance, and the tabulating of accurate data. If the goods are there, the diamond-drill will uncover them; if

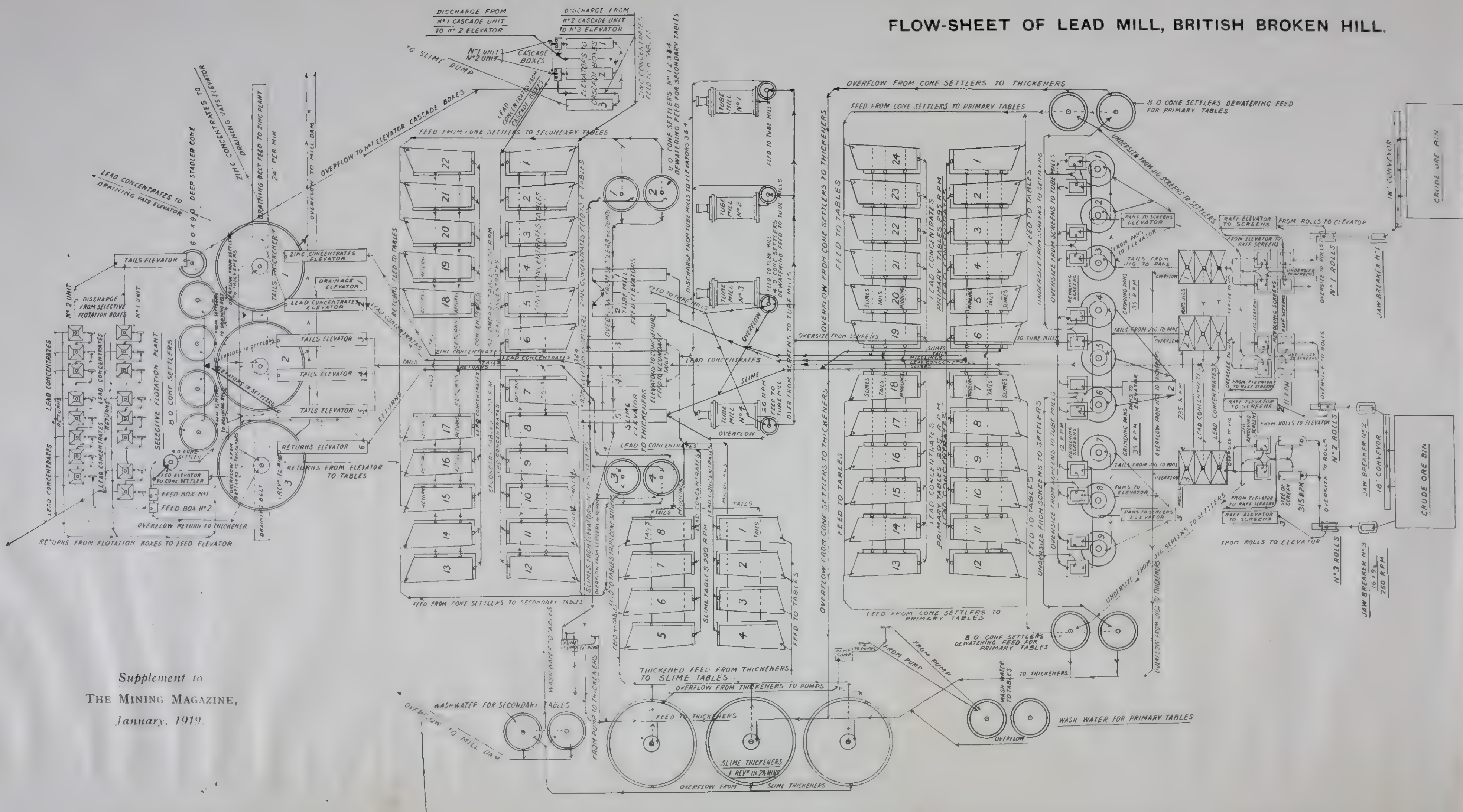
FLOW-SHEET OF ZINC PLANT

BRITISH BROKEN HILL.

Supplement to THE MINING MAGAZINE, *January, 1919.*



FLOW-SHEET OF LEAD MILL, BRITISH BROKEN HILL.



Supplement to
THE MINING MAGAZINE,
January, 1919.

they are absent it will also denote that fact. No mine of any extent can economically carry out development without the diamond-drill, and with the diamond-drill it is rather hard to accomplish stock-market inflation. In fact, the greatest opponent the diamond-drill has is the stock-market miner.

With the diamond-drill, the preparation of an assay plan of any mine becomes, generally speaking, a simple operation. Mines and prospects that cannot be developed along other lines can be developed by diamond-drilling. Abandoned mines can be proved without the expenditure of huge sums for reopening purposes until it has been conclusively proved whether they warrant it or not. I do not think I am exaggerating, or going beyond simple facts, in saying that, foot for foot, Cornwall is the richest mineral portion of the globe, and nowhere else are there offered so many opportunities for the use of the diamond-drill.

Are all the abandoned mines of Cornwall unproductive? Was it lack of material or inefficient systems that caused their abandonment? Most probably the latter. I am convinced that a judicious use of the diamond-drill in the abandoned areas of Cornwall would prove that a large percentage of the abandoned mines are still capable of being worked at a profit. And to one who has witnessed the advantages accruing from a wide use of the diamond-drill in other parts of the world's mining areas, it would seem that a wider use of the diamond-drill in Cornwall is one of the glaring necessities of Cornish mining of to-day.

CONCENTRATION AT THE BRITISH BROKEN HILL

By GEORGE C. KLUG, M.Inst.M.M.

THIS article and the accompanying flow-sheet describe the method adopted by the British Broken Hill Proprietary Company for the treatment of its ore. The ore is more silicious and rhodonitic than calcitic in character.

The crude ore is delivered from three hauling shafts to the crushing plant. That from one of the shafts goes direct from the brace in the mine trucks, and that from the other two by an aerial tram. The crude ore is crushed in a No. 6 Gates and a No. 5 Austin gyratory crusher and conveyed by an 18 in. belt-conveyor to storage bins; from these the concentration plant, which is divided into three sections, draws its ore supply. After passing through three 16 by 9½ in. jaw crushers of the Blake type, the ore is delivered into three sets of Cornish rolls 32½ in. diameter by 17½ in. face, driven at a speed of 15½ revolutions per minute. The product from the rolls gravitates to three Raff elevators by means of which it is elevated and delivered to the Raff screens. Sections 1 and 2 each contain two revolving screens fitted with screening of 36 holes per square inch, while section 3 has two shaking screens with ⅛ in. round holes. From the Raff screens the oversize gravitates back to the rolls, and is re-ground. The undersize is delivered to revolving screens called the jig screens, two to each section, which are fitted with screening having 900 holes per square inch. The undersize from these jig screens gravitates to the de-watering cones, and is a portion of the feed for the 24 primary tables. The oversize from the jig screens gravitates to the May three-hutch jigs, one jig in each section. The discharge from Nos. 1 and 2 hutch in each jig is lead concentrate, and this gravitates into the main lead concentrate launder. The discharge from No. 2 hutch can be returned to the Raff elevators if necessary. The discharge from No. 3 hutch, called jig tails, gravitates to the 8 ft. grinding pans, three pans to each section.

The overflow from the jigs gravitates to the three 20 ft. Dorr slime-thickeners. From the 8 ft. grinding pans the pulp gravitates to the pan elevators, one to each three pans, and is elevated and delivered on to revolving screens called the pan screens, four screens to each section, with screens having 500 holes to the square inch. The undersize from these screens gravitates to the 8 ft. diameter de-watering cones. The oversize from the pan screens gravitates to the tube-mill feed cones. The overflow from the 8 ft. diameter de-watering cones gravitates to the 20 ft. Dorr slime-thickeners. The bottom discharge or thickened product from the de-watering cones gravitates to and is feed for the 24 primary tables.

The lead concentrate from the 24 primary tables gravitates into the main lead concentrate launder. The slime product from the primary tables gravitates to the slime elevator No. 5 on the tube-mill floor. The middling and tailing from the primary tables gravitates to the two elevators on the tube-mill floor, Nos. 1 and 2, feeding the tube-mills. The pulp from these two feed elevators, together with the oversize from the pan screens, is delivered in 4 ft. diameter de-watering cones, four in number, one at the head of each tube-mill. The bottom discharge from these cones feeds the tube-mills, while the overflow is elevated to the three Dorr slime-thickeners.

The ground product or discharge from the tube-mills gravitates to the two elevators Nos. 3 and 4 on the tube-mill floor. This pulp is elevated into 8 ft. diameter de-watering cone settlers. The bottom discharge from these 8 ft. diameter cone settlers gravitates to the secondary tables, and the overflow is pumped up into the three Dorr slime-thickeners. These receive all the slime pulp and overflow from the slime elevator No. 5 on the tube-mill floor, from all the de-watering cone settlers above mentioned, and from the three May jigs.

The bottom discharge or thickened pulp from the three thickeners gravitates to and is feed for the eight slime tables. The overflow from the Dorr slime-thickeners is used for wash water for the primary, secondary, and slime tables. The lead concentrate from the eight slime tables gravitates to the main lead concentrate launder. The middling product from the slime tables gravitates into the elevators Nos. 3 and 4 on the tube-mill floor feeding the secondary tables. The tailing from the eight slime tables gravitates to the elevators Nos. 3, 4, and 5 at the bottom of the lead mill.

There are 22 secondary tables. Eleven of these tables are used for the bottom discharge product from the four 8 ft. diameter de-watering cone settlers. Five are used for returns, and six of them for de-leading the mixed lead-zinc concentrate from the zinc plant. The lead concentrate from all of these tables gravitates to the main lead concentrate launder. The return product from 6 of these tables gravitates to the No. 6 elevator at the bottom of the lead mill. The tailing from the latter tables gravitates to elevators Nos. 3, 4, and 5 at the bottom of the lead mill. The zinc concentrate from the six tables used for de-leading the mixed zinc-lead concentrate gravitates to the zinc concentrate elevator at the bottom of the lead mill, and is elevated and delivered into the zinc concentrate elevator at the zinc concentrate drainage vats.

All the lead concentrate above mentioned from this portion of the plant gravitates to the lead concentrate elevator No. 2 at the bottom of the lead mill, and is elevated and delivered into the lead concentrate elevator at the lead drainage vats. The drainage elevator No. 1 at the bottom of the lead mill elevates all the drainage in this elevator pit, and delivers it into the return elevator No. 6 at the bottom of the lead mill. The three tailing elevators Nos. 3, 4, and 5 at the bottom of the lead mill deliver their pulp into four 8 ft. diameter diaphragm cone settlers at the bottom of the lead mill. The overflow gravitates to the three 20 ft. diameter Dorr thickeners at the bottom of the lead mill, while the thickened product from the diaphragm cone settlers is delivered on to the draining belt and is conveyed to the zinc plant.

The overflow water from the three 20 ft. diameter Dorr thickeners at the bottom of the lead mill gravitates to the lead mill water supply dams. The thickened pulp or discharge from the bottom of these three Dorr thickeners gravitates to the feed elevator delivering the pulp to the Lyster selective flotation plant at the bottom of the lead mill. The pulp is elevated into a 40 ft. diameter cone settler. The bottom discharge from this gravitates back to the return elevator No. 6 at the bottom of the lead mill, while the overflow gravitates to two feed boxes, one feed box to each unit of eight Lyster selective flotation boxes. The pulp is taken from the bottom of the feed boxes by the first centrifugal pump in each unit, and is delivered into the first flotation box in each unit. The discharge from the bottom of the first flotation box is pumped into the second flotation box in each unit, and so on until the eighth flotation box in each unit is reached. The bottom discharge from the eighth flotation box in each unit gravitates to the tailing elevator at the selective flotation plant, and, together with the drainage from the draining belt, etc., is elevated and delivered into a 6 ft. diameter by 9 ft. deep Stadler cone. If there is any overflow from the two feed boxes for the selective flotation plant above mentioned, it gravitates back to the Dorr thickeners.

All the lead concentrate from the selective flotation boxes gravitates into settling boxes, and from these the lead concentrate is taken out and spread on drying floors, preparatory to loading into the slime concentrate bins.

The thickened product from the Stadler cone above mentioned gravitates on to the draining belt. The overflow from the Stadler cone gravitates to two elevators, Nos. 1 and 2, feeding the two units of cascade flotation boxes. The two cascade flotation units contain one feed box, six cascade flotation boxes, and one discharge box to each unit. The feed elevator No. 1 delivers the pulp into the box feeding the first unit of cascade flotation boxes. From the bottom of the feed box, it gravitates through nozzles, three in each box, into the first cascade flotation box, and from the bottom of this, it again gravitates through nozzles, three in each flotation box, into the second cascade flotation box, and so on until the discharge box is reached. From the discharge box of the first unit, the pulp gravitates to No. 2 feed elevator, and is elevated and delivered into the feed box of the second unit of cascade flotation boxes, and gravitates through this unit in a like manner as described above. From the discharge box of the second unit, the de-leaded pulp gravitates to No. 3 elevator, and is elevated into a launder in which it gravitates to the slime dump. The lead concentrate from all the cascade flotation boxes gravitates into the lead concentrate elevator, No. 2, at the bottom of the lead mill.

The zincy tailing from the lead mill is collected on a draining belt at the bottom of the lead mill and is delivered by means of No. 1 and No. 2 conveyors into the feed hopper feeding the Minerals Separation mixer boxes. This, together with the make-up water, which is also added in the hopper, gravitates into the first or No. 1 mixer box, where the acid solution and eucalyptus oil are added. The oil can also be added to Nos. 2 and 3 mixer boxes if required. For maintaining the necessary temperature of the pulp provision is made for admitting steam into the No. 1 mixer box. The discharge from this box passes through No. 1 flotation box. From the bottom of the flotation box, the feed passes into No. 2 mixer box, from the mixer box into No. 2 flotation box, and so on till No. 12 flotation box is reached. At the present time, only ten boxes are used. The float or mixed blende and galena concentrate from the first six boxes gravitates to and is feed for the six de-leading Wilfley tables on the secondary tabling floor of the lead mill.

The float or overflow from Nos. 6, 7, 8, 9, 10, 11, and 12 boxes can be returned, if found necessary, in which case it gravitates to the return elevators, Nos. 1 and 2, at the back of zinc plant, and is elevated and delivered into the feed hopper for re-treatment. The discharge or residues from No. 10 flotation box gravitates into a distributing box. The discharge from Nos. 6, 8, and 12 flotation boxes can also gravitate into the distributing box if found necessary. From the distributing box, the pulp or residues can gravitate to each or any number of the four 8 ft. diameter de watering cone settlers at the foot of the zinc plant, the overflow gravitating into two Dorr thickeners. The bottom discharge from the four cone settlers gravitates on to the residue draining belt. The overflow from the two thickeners gravitates to the zinc plant supply dams.

The thickened pulp from the bottom of the thickeners discharges on to the residue draining belt. All the drainage from the draining belt, etc., gravitates to the drainage elevator, and is elevated and delivered into a 6 by 9 ft. de-watering cone settler.

The overflow gravitates into the two Dorr thickeners, and the thickened product from the cone settler gravitates to the residue draining belt. From the draining belt, the residue or final tailing is transported by a system of 18 in. belt conveyors, the arrangement of which permits of the tailing being delivered on to the residue dump, or into a storage bin for transport by aerial tram into underground passes for stope filling purposes.

The dumping floor is for receiving the tailing from No. 1 feed belt-conveyor in the event of temporary cessation of operations in the zinc plant. When this material is wanted again, it can be fed on to an 18 in. belt-conveyor which returns it and delivers on to No. 1 feed belt-conveyor.

The capacity of the mill is from 30 to 35 tons per hour.

English Tin Ore Production, 1917.

The Mines and Quarries Report, Part III, for 1917, gives the following figures for the output of tin concentrate in England during that year, with the amount of tin obtainable by smelting :

	Concentrates			Tin obtainable by Smelting	
CORNWALL	Tons	cwt.		Tons	cwt.
From Mines	5,230	11	...	3,432	9
From Quarries	8	15	...	5	16
From Foreshores, refuse of dressing floors, &c.	954	4	...	311	12
From old dumps at surface	349	18	...	165	9
Total	6,543	11	...	3,915	[illegible]
DEVONSHIRE :					
From Mines	31	7	...	20	11
From Quarries	0	17	...	0	12
Total	[illegible]	[illegible]		[illegible]	[illegible]
Grand Total	6,575	15	...	3,936	9
Total for preceding year	7,892	3	...	4,697	3

The average percentage of metallic tin obtainable in the case of ordinary concentrates was 65·6. The produce of the stream works yielded an average percentage of metal of 32·7.

THE GOLD PROBLEM.

REPORT OF THE GOVERNMENT GOLD PRODUCTION COMMITTEE.

We give herewith the opinions of the Government Committee, appointed to investigate the problem of maintaining the output of gold in face of increasing costs at the mines. The members of the Committee were Lord Inchcape, Sir Thomas Elliott, Sir Charles Addis, and Mr. W. H. N. Goschen

THE Committee, in their report, begin by reviewing the evidence of the Gold Producers' Committee, which was formed by representatives of the South African and other gold mines and the Institution of Mining and Metallurgy. After reviewing the evidence presented, the Committee reports as follows:

The Gold Producers' Committee thought that the maintenance of, or increase in, production would be temporary only. They stated that the result would be obtained by taking, as they said, the eyes out of the high-grade mines, that is, by working only the richer ore, thus shortening by some period, which could not be determined, the life of the mines. They ascribed the closing down of the two or three mines which had been abandoned since 1914 to a variety of causes, not necessarily to increase in cost only. In answer to the specific questions as to what extent the falling off in production was due to the increase in cost, the witnesses stated that it would be very difficult to separate the figures, and that a very technical examination, which could not be made in London, would be required. Our witnesses, however, "thought it safe to say that the main cause of the decline in production, so far as the Rand were concerned, was increased cost." They admitted the great importance of the question for the purpose of our inquiry, and when further pressed, stated that the relation between the various causes of the decline could not be given. It is, however, obvious that a mine on the border of payability becomes definitely unpayable on an increase of costs, and we were given as an instance the closing down of the Great Fingall mine, one of the two cases, both in Australia, in which it has been definitely stated that a mine has in fact had to close down since the war owing to increased cost. The witness in this case was not, however, able to state how long the mine might have been carried on but for the rise in cost.

We attribute the decline of £1,100,000 in the Transvaal as a whole between 1916-17 mainly to shortage of explosives caused by the war. We have been informed by the Gold Producers' Committee that the supply of explosives is now ample. In 1918 the decline in labour—due, we are told, to the reopening of the diamond mines—which set in in 1917 made itself felt, and the fall in production between 1917-18 appears to be due mainly to that cause. We are not satisfied that so far as the Transvaal as a whole is concerned the increase in cost of working affected the output in either year. The decline in the production of the low-grade mines during the war appears to us to be due to the normal falling off in the value of the material treated. With regard to Australasia, we were told that in addition to the gradual falling off of the value of the ore, the labour shortage has throughout the whole period of decline in production been largely responsible for it, and that during the war especially there is no doubt that the shortage of labour and the inefficiency of the remaining supply was an overwhelming factor in the difficulty. It may be worth while at this point to refer to some reports published in the press while we have been sitting of the quarterly results of six mines of the Barnato Group. In five cases the increase or decrease in crushing was ascribed to increase or decrease in labour supply. In the remaining case, the increase was said to be due to the use of enlarged reduction plant.

As to the future, it has been represented to us that having regard to the increase in cost, unless assistance is given, low-grade mines producing in normal times payable ore will be obliged to shut down and higher-grade mines will in their operations leave behind low-grade ore which in normal times would have been worked, thus shortening their lives for some period which cannot be determined. But the argument is, in our view, directed rather to the interests of the mines than to the question of gold supply, unless it can be shown that we are within measurable distance of the exhaustion of gold, and it appears to us that anything in the nature of a subsidy per ounce produced, as has been suggested by the Gold Producers' Committee, would be an inducement to a mine to work the better ore.

Peace may be expected to bring about the immediate disappearance of such part of the increase in the cost of mine supplies as is due to the increase in cost of freight and insurance, but how soon prices will return to normal we do not venture to predict. One of the witnesses in South Africa gave nine months as a period likely to elapse before they would do so. As regards realization charges and cost of insurance and freight, there has been an increase of 8·38d. per oz. in the cost since 1911, accounting for £350,000, according to our witnesses. This may be expected to disappear when peace is signed. It is believed that to a large extent it has already done so, the cost of freight and insurance being now very little over pre-war level. A comparison of the charges for refining in London, which are, however, a matter of private arrangement between the producers and the refining firms, and the Mint prices in Canada and Australia might be of interest. The Gold Producers' Committee, however, regarded the refining charges as a matter of little moment and we have not therefore thought it necessary to examine them in detail.

There remains the question of the supply of labour in South Africa, with regard to which certain suggestions have been made both to ourselves and to the Committee in South Africa. The question is, in our view, entirely a matter for the Union of South Africa. There is, however, some evidence as to the effect of the return of peace on the question. Mr. Wallers stated before the Committee in South Africa that "the demand for native labour in other industries has steadily increased and is likely to continue to increase, having regard to the restrictions on the importation of material necessitating further labour for local manufacture, the renewal of operations in the diamond mines, the increasing operations of the collieries, the opening up of new gold-mining areas on the Far East Rand and the insistent demand for native labour of the farmers." In Mr. Wallers' view, possibly the return of the native labour contingent from the war may bring about an amelioration.

We have now to examine the suggestions for meeting the situation which have been made both to the Committee in South Africa and ourselves. All of them contemplated assistance in money, in different forms and for different purposes, and two them at any rate are directed to remove an alleged cause in the decline of gold production, which we are unable to regard as the primary cause. These suggestions cannot in our view be entertained, but we are satisfied that they were made only after the fullest consideration, and therefore deserve careful examination at our hands.

Two suggestions were made to the Committee in South Africa. The Chamber of Mines proposed the closing down by agreement of six selected low-grade mines, the distribution among the rest of the labour and materials released, and a subsidy to be provided by the Government to the mines selected for shutting down, to enable them to maintain pumping and other necessary work to provide for eventual reopening. The amount of subsidy required was given at not more than £150,000. The Consolidated Gold Fields of South Africa suggested a State subsidy per ton of ore milled to enable such of the poorer mines as had a probable life of five years or more to cover any deficit in the cost of working. They proposed, further, the formation, if necessary, of a Government Committee to control output, development, and the allocation of native labour and explosives. The amount of the subsidy required for some fourteen low-grade mines was given as £183,000. The Committee was unable to recommend the granting of subsidies as suggested by either the Chamber of Mines or the Consolidated Gold Fields. Its report on these suggestions is as follows: "Your Committee is unable to recommend the granting of subsidies as suggested by the Transvaal Chamber of Mines and the Consolidated Gold Fields of South Africa, Limited. It is unable to see any justification for a grant from public funds and is of opinion that subsidies would constitute a bad precedent and that it would be very difficult to keep them within reasonable limits. The Government would have to satisfy itself that its subsidy was economically used and not wasted in careless working or unnecessary costs, and no supervision could adequately ensure this, short of complete control by the State. It would be most difficult to justify the payment of such a subsidy to some mines and not to others which might be considered to be equally deserving of assistance by the companies owning them, or by the communities interested in their being kept open, and the Government would be faced with a demand to which no limit can be foreseen, not only from mining on the Rand, but also from other industries and communities." We entirely agree. The Committee, however, as we have stated above, recommended that steps should be taken to control (*a*) the amount of development work that may be carried on by each mine; (*b*) the allocation of stores and especially explosives; (*c*) the allocation of the available labour force.

It has been represented to us that the expedients proposed to the South African Committee are quite insufficient, and the Gold Producers' Committee have stated as their opinion that "if it is desired to maintain the existing production of gold, as far as the Witwatersrand goldfield is concerned, about 12s. 6d. per standard ounce of raw gold would counteract the present increased cost of production, and would tend to check a further decline in the output, but it is by no means certain that it would restore the pre-war output." The witnesses calculated that a subsidy of 12s. 6d. per standard ounce of raw gold throughout the Empire would cost £7,000,000. We were at some pains to discover what we should get in return. Our witnesses, however, admitted that it would be an experiment merely. They could say no more than that "the extent to which the subsidy would affect the gold output would depend enormously upon the labour supply and a few other conditions," and that, while a Government subsidy would not necessarily produce more gold, "given a subsidy the Witwatersrand would make every effort to, and would hope to continue to, produce gold at the rate of £7,000,000 a year which would not otherwise be produced." Our witnesses admitted that from the point of view of the purchaser the grant of a subsidy in addition to the price would amount to an increase in price. They agreed without hesitation to the importance of obtaining the standard price of gold. But the conclusion is irresistible that gold cannot be purchased at 23s. 9d. per sovereign concurrently with the preservation of the gold basis which assumes the maintenance of the existing fine content of the sovereign, as to the importance of which there can, we think, be no difference of opinion.

A subsidy for the production of gold appears to us to be fundamentally unsound. Gold has been adopted as the standard of value because, by reason of the operation of natural causes, it is available in such quantities and at such a cost of production in terms of other commodities as to give it a more or less stable value. Its value, in terms of commodities, is directly influenced by the laws of supply and demand. Periods of increased gold production, following on the discovery of further deposits of gold capable of extraction at a low cost, have been marked by an increase in the price of commodities. The exhaustion of these sources of supply has been accompanied by a decline in the price of commodities. The intention of the subsidy suggested by the Gold Producers is to enable gold to be produced which otherwise would not, conformably with the economic laws of supply and demand, be produced at all. Other things being equal, the result would be that the purchasing power of the world's gold would be diminished *pro tanto*. The value, in terms of gold, of the commodities for which it is exchanged would rise.

It is undoubtedly desirable that considerable gold reserves should be held in this country, but in our view the most important function of a gold reserve is that gold from the reserve should be available for export at the standard price when required to meet foreign indebtedness. We think it essential to preserve a free market in gold, but clearly it would not be a business proposition to do so if we had to pay £4. 10s. 3d. for an ounce of gold in order to export it at £3. 17s. 10½d. We can only maintain our gold reserves in this country if the value of our exports, visible and invisible, exceed on the balance the value of our imports. If we want gold and cannot produce it at a profit, we must depend on our capacity to render services and to produce at a profit the commodities wanted elsewhere by the holders of gold, and to do so we must adjust our prices to world prices. We shall not be able to keep gold which we acquire by means of a subsidy if the balance of trade is against us, and apart from the shareholders in gold-mining concerns, whose gain would be merely temporary, the only people who would benefit by the subsidy would be the foreign purchaser of the gold. The London Chamber of Commerce apprehend that prices may fall rapidly at peace with disastrous results to industry, and contend that it might be in the public interest to take steps to prevent the rapid fall in the price of commodities by stimulating the production of gold at the expense of the taxpayer. We neither share their apprehension nor accept their contention. To give more for an ounce of gold than it is worth in currency appears to us out of the question, except on the supposition that we want gold for the purpose of keeping it locked up and unavailable for export. We cannot, however, see any use in acquiring gold for such a purpose.

We have no reason to believe that there will not be forthcoming from the British Empire on a parity basis as much gold as we shall need for the purpose of strengthening our reserves, but in any case the additional amount of gold which at the best we could hope to secure by a subsidy would, in the opinion of our witnesses, be of no advantage to this country for building up reserves unless we can afford to keep it.

There is one other matter on which we think it right to make some observations. There appears to exist a widespread impression that in some way the gold-mine owner has suffered unfair treatment, that in the words of one of our witnesses, he had been "damnified" by the action of the Government. It is apparently widely thought that he has been compelled to deliver the whole of his products to the Government and that he has suffered by the issue of currency notes. It seems to us that had not the Bank of England been willing to take his products, he would have been unable to market them at all during the war or at most only to a very limited extent, and we have ascertained that so far from it being the case that any pressure was exercised upon him by the Government he accepted readily an arrangement under which the Bank of England agreed to take the whole of his products. Further the Bank took delivery of the products in South Africa at the standard price less an agreed charge for freight, insurance, and refining and other charges ordinarily borne by him, the agreed charges of 25s. per cent. being much less than the charges he would otherwise have had to pay. The insurance alone would in 1917-18 have amounted to 5 guineas per cent. On deposit of the gold in South Africa he obtained an advance in London of $98\frac{3}{4}$ per cent. of the value, thus gaining at least three weeks' interest. It is calculated that he saved by the arrangement some 3s. 4d. per oz., a real benefit to him, not in the least affected by the fact that the Bank were able to secure it for him, in view of the special arrangements which they were in a position to make, without themselves incurring any additional expenditure in procuring gold. Lastly, it was open to him at any time to cancel the arrangement. The gold producers have argued that the unavoidable expansion of currency by the issue of currency notes has raised prices against them unduly as against the producers of other commodities who have been able to obtain higher prices for their products, but it is to be remembered that the gold producers have always had the advantage of the standard price of their product during the periods when the price of other commodities has fallen. We cannot therefore agree that the sense of grievance is well founded in fact.

We summarize below the result of our inquiry. We find:

(1) That taking the period of the war on a whole the production of gold in the Empire exceeded the production during the corresponding period immediately preceding it.

(2) (*a*) A decline appears for the first time during the war in 1917. In 1917, as compared with 1916, there was a reduction in the value of gold produced in the Empire of £3,429,415, made up as follows, the figure for Australasia being an official estimate: Transvaal £1,183,141; Rhodesia and West Africa £484,677; Australasia £906,600; Canada £777,914; India £77,083; total £3,429,415. (*b*) In 1918 a further fall of £4,652,207, as compared with the 1917 production, is anticipated, made up as follows, the figures for Australasia and Canada being estimates not based on any ascertained figures, none being available in London: Transvaal £1,827,163; West Africa and Rhodesia £734,299; Australasia £1,401,400; Canada £674,586; India £14,759; total £4,652,207. (*c*) That the decline in the Transvaal in 1917 was due to a combination of shortage of explosives and shortage of labour, of which the shortage of explosives due to the war was the more important, and in 1918 mainly to the shortage of labour not due to any large extent to the war. (*d*) That the decline in Australasia in 1917 and 1918 was normal and due in the main to natural causes, but that it was accelerated by the increase of costs and decrease in efficiency of labour caused by the war.

(3) That up to the date of our appointment the treatment of low-grade ore in the Transvaal has not to any extent which can be determined been reduced by the war.

(4) That from the point of view solely of gold production the abandonment of the treatment of low-grade ore in favour of higher-grade ore will not within any measurable period reduce the total output of the Empire, and that the continuance of the working of low-grade mines which are unable to work at a profit to themselves is not therefore a matter of any great importance to national interests.

(5) We are not prepared to recommend any bounty or subsidy for the purpose of stimulating the gold output of the Empire; gold being the standard of value no more can properly be paid for it than its value in currency.

To the Committee's report is attached a memorandum on the world's gold production, prepared by Professor William Frecheville. He shows that the continual improvements in mining and metallurgical methods tend to make the exhaustion of the older districts slower than may be calculated from any data available at any given time, and that on the other hand the periodical discovery of new districts makes it impossible to forecast with any degree of accuracy what increases the future may have in store.

NEWS LETTERS.

TORONTO.

December 6.

PORCUPINE.—The labour situation in the mining districts has been considerably relieved by the closing down of the munition plants. The number of workers employed in war industries in Canada was estimated at over 200,000, of whom a considerable proportion have already been released. The making of munitions ceases entirely on December 14, when the problem of providing work for those suddenly thrown out of employment will become serious. So far most of the discharged men and women have had little trouble in finding other work, as labour in all lines of industry has been much in demand. Many are finding their way to the mining centres, which can readily absorb several thousand additional workers. For reasons previously mentioned, the shortage of labour has been more seriously felt in Porcupine than in the other mining districts, and the influx of labour will, it is anticipated, result in the resumption of many temporarily suspended enterprises and a largely increased production.

The Dome Mines, at which milling operations have been suspended for nearly a year, is likely to resume production early in the new year. While no official information is obtainable, it is generally believed that the result of development at depth has raised the average grade of the ore reserves to about $8 per ton. Reports of an important strike on the Dome Extension, which is being developed at the 1,250 ft. level from the Dome, though unconfirmed officially, were accepted seriously on the stock market and resulted in a rise in the price of shares. The shareholders of the Schumacher have authorized the issue of 100,000 shares of treasury stock at a discount of not less than 55% to raise funds for carrying on development. Encouraged by the success of the Hollinger Consolidated and the McIntyre mines adjoining their property, the directors of the Schumacher have adopted a policy of deep mining. At the McIntyre an extensive programme for development at the 1,350 ft. level, which will be the deepest working in Porcupine, is planned. An electric haulage system will be installed on this level, which will greatly facilitate the handling of the ore. Ultimately it is proposed to sink considerably deeper. The cross-cut on the 1,000 ft. level of the McIntyre has advanced 600 ft. into the Plenaurum property, and explorations by diamond-drilling at different points along the drift indicate high-grade ore. A rich strike of ore has been made on the 500 ft. level of the Davidson, which is now operated by electricity.

KIRKLAND LAKE.—The Lake Shore, which has now definitely taken its place as a leading producer, has declared a second dividend of 2½%. The monthly production shows a steady increase. The main shaft of the Elliott-Kirkland is being put down from 500 to 600 ft., diamond-drilling having proved a considerable extension of the porphyry formation at the lower level. At the Burnside, milling equipment is being rapidly installed with the object of beginning active production before the end of the year. The Ontario-Kirkland is putting in an electrically-driven mining plant at a cost of $15,000. A contract has been let to sink the shaft from 100 to 300 ft. Work on the foundation for the mill at the Wright-Hargreaves is making good progress. The machinery will be brought in during the winter.

BOSTON CREEK.—On the Cotter property adjoining the Miller Independence a 3 ft. vein carrying tellurides has been opened up on the surface. The eastward continuation of the Miller Independence vein has been cut by diamond-drilling. The development of the main vein of the Miller Independence continues to yield rich ore. The pay-streak of 4 ft. wide carries tellurides of gold in large quantities, in addition to which there is 6 to 8 ft. of milling ore. On the Campbell group of claims a strong vein containing visible gold and tellurides has been opened up.

COBALT.—Silver production for the first nine months of the year shows a marked decline in quantity, but an increase in value as compared with the output of the corresponding period of 1917. This year the production was 13,145,596 oz. of the value of $12,500,980, as compared with 15,236,002 oz. valued at $12,001,857. The Nipissing, during October, mined ore of an estimated value of $278,468, and shipped products from Nipissing and custom ore of an estimated net value of $545,135. Underground developments were favourable, the most important being the improvement of a small vein found on the 4th level of 73 shaft, which, on being followed up, widened to 3 to 4 in. of ore assaying over 2,000 oz. A new shaft is being put down in an undeveloped area near the edge of Cobalt Lake. The annual statement of the Hudson Bay for the year ended August 31, showed a total income of $129,860 and profits of $32,402. Ore reserves were estimated at 60,149 oz. At the

Gifford, a drift run on the 350 ft. level has encountered two veins, which are believed to be a continuation of the vein system of the Beaver. A vein of high-grade ore has been found at the 60 ft. level of the Foster mine, stated to average 5,000 oz. to the ton. The Hargrave was closed down after a long-continued, but fruitless, attempt to strike the extension of the high-grade vein system of the Kerr Lake. The vein cut at the 310 ft. level of the Adanac has considerably improved, recent assays showing nearly 400 oz. to the ton.

GOWGANDA.—There has latterly been a good deal of activity in this district. The Miller Lake - O'Brien is developing a new vein, stated to be 12 in. wide with ore running between 4,000 and 4,500 oz. per ton. The Trethewey of Cobalt is operating the Castle property, and has encountered a series of promising veins in the shaft. The Crews-McFarlane is working a 12 in. vein yielding a good grade of ore. A number of other properties in this area have been actively developed during the summer and autumn. Operators are anticipating the extension of the railway to Gowganda, which would greatly stimulate the mining industry.

KALGOORLIE

September 26.

A SODA INDUSTRY.—The desire of Australians to found local manufacturing industries, based on the natural resources of the country, is widespread. In West Australia attention is being turned to the salt deposits, which hitherto have only been a nuisance. There does not seem to be any reason why the Solvay, or ammonia-soda, process should not be applied to the salt in order to produce soda. Hitherto soda-ash and soda crystals have been imported. A writer in the *Australian Statesman and Mining Standard* says that, owing to the scarcity of these commodities, due to restricted shipping, attention has been turned toward the possibility of taking advantage of some of the resources of the Commonwealth. To this end inquiries are being made in both Queensland and West Australia, but it is in the latter State that the prospects for the establishment of the industry on a large scale would appear to be particularly bright. Indeed, the conditions in the Western State are said to be exceedingly favourable in this respect, and if put to commercial use may be the means of supplying the needs of Australian consumers for an almost indefinite period. Inquiries are at present being made into the possibilities of the venture by a member of the firm of Felton, Grimwade, and Bickford, a firm of wholesale druggists and chemists. Many tests have yet to be made, and much time and thought devoted to the matter, before anything of a decisive nature can be arrived at, but if expectations, born of a knowledge of the natural resources that are awaiting development, are realized, there should be launched in West Australia one of the largest projects it has ever had the good fortune to see.

The principal constituents that are required in the manufacture of soda-ash by the Solvay process are salt, lime, coal, and water. All these elements are found in West Australia in unlimited amount, and within a hundred miles or so of the capital. A peculiar feature about the salt and the lime deposits in question is that each of these exists in the form of a lake, divided only by a narrow strip of country. Lake Preston contains the salt of a character that is said to be peculiarly suitable for this particular purpose, and Lake Clifton contains the limestone in a form that is reputed to be eminently fitted for the requirements. These lakes are situated between the South-Western railway and the sea coast, and a few miles of rails only are required to connect them with the means of transit to either Fremantle or the port at Bunbury. The Collie coalfields are also reached by a spur line from the South-Western railway, and no difficulty, therefore, should be offered to getting an adequate supply of fuel at low cost. Water also is readily obtainable.

The lime deposits at Lake Clifton are now about to be made use of for the manufacture of cement on a large scale, the lease previously held by West Australian residents having been disposed of to a Sydney firm for a sum approximating, it is said, £25,000 and a certain proportion of vendors' shares. Seeing that there are claimed to be millions of tons of almost pure lime in the bed of the lake there should be little trouble in an amicable arrangement being effected between the lime company and an alkali company for the supply of lime. There could also be co-operation between the respective organizations in the matter of coal supplies, and in other directions in which their interests would be interwoven. The lime and cement works may be looked upon as an accomplished fact, one of almost immediate realization. It will be interesting to know whether Lake Preston will find equal favour in the sight of man, so that its waters may be utilized for the benefit of the race.

It may also be of interest to state that the Perth and Fremantle Bottle Exchange Company has already prepared plans for the erection of bottle works in West Australia, and that a similar project is also under consideration at the hands of the Australian Glass Manufacturing Company, Victoria, both of which enterprises would have reason to rejoice if adequate supplies of soda-ash were forthcoming from such a convenient centre.

CHARCOAL PRECIPITATION.—This subject was discussed in a paper recently read by L. B. Benjamin at a meeting of the West Australian Chemical Society. He brought out some points not greatly stressed in previous literature. The charcoal is of course very fine. It may be taken that 2·5% is less than 0·01 mm.; 25% is between 0·01 and 0·003 mm.; and 72½% is less than 0·003 mm. So the greater portion is well below any screen size (150 mesh = 0·09 mm. holes). The reasons given for the precipitation provoked discussion. At any rate the carbonyl-compound theory was scouted. A theory based on adsorption seems to indicate that charcoal, cooled slowly in air or other gases, adsorbs almost to the limit of its power, whereas when cooled as it is in the water seal (that is, quickly, with evolution of steam, etc.), it has not adsorbed gases to any great extent and therefore when used in the precipitation vat it is practically fresh for adsorption of gold and other compounds. A selective action, whereby gold is adsorbed in preference to other elements, is traced to high atomic weight of the element. Apparently analyses are required of the charcoal before use, and after saturation with the gold compound. It was shown during the lecture that, if a solution containing carbon particles in suspension be electrolysed, the carbon migrates first to the anode, carrying its charge, deposits it, and then streams off in the direction of the cathode, apparently with another charge of opposite sign. Some particles on their way to the anode meet with particles moving to the cathode. A neutralization of charges probably results, for, after a time, some particles are seen to settle out of the suspension.

MINERAL DEVELOPMENTS.—Alunite is found extensively at Kanowna, the old white clays of this region being found to carry appreciable quantities of the mineral in certain areas. It is hoped that K_2SO_4 at least will be extracted, but a more or less pure alumina will result from the roasting and extraction. Wolfram is gaining in importance, but the ore of tungsten receiving most attention is scheelite. The Government is erecting a plant for the treatment of the ore at Coolgardie. The Northampton lead mines are keeping active. The smelters at Fremantle make ingot lead of 99·9% purity, copper being the chief impurity. There is little silver or zinc in West Australian galena. An investigation of Westralian clays is proceeding, and it is hoped that a comprehensive report upon clays varying from ordinary brick and building clay up to finest grades for porcelain and china will shortly be under way. It is hoped shortly to have glass works here, as mentioned earlier in this letter, and an investigation of glass-making sands reveals the fact that there are good grades here for all purposes. Two or three samples rival the best Belgian and Fontainebleau sand.

NORTH OF ENGLAND.

LEAD AND ZINC.—The output of zinc and lead ore is steadily falling. It is due to several causes. One is the shortage of labour; but about that nothing need be said, if only because the scarcity of hands has been felt by almost every industry in the country. Another cause concerns the question of prices. There was no very large increase in price in the early part of the war. The mines were compelled to extract the proved deposits, and the development in the mines was considerably curtailed. Owners had in fact to get revenue at the cost of development. The position was bad enough soon after the outbreak of war, but it grew steadily worse as time wore on, and at the present time a great number of the mines are suffering on account of their resources of ore in sight being so much lower than they were in July, 1914.

Some statistical information may be here given which will be found illuminating.

TONNAGE OF GALENA IN THE UNITED KINGDOM.

	Tons raised	Mean price of galena received by mines			Average Price Pig Lead foreign			Ratio % between galena at mines and price of lead
		£.	s.	d.	£	s	d	
1912	25,409	11	12	10	17	15	10	65·4
1913	24,[illegible]	12	1	0	18	6	2	65·7
1914	26,013	11	18	2	18	13	9	63·7
1915	20,744	14	4	5	22	17	8	62·1
1916	17,107	19	16	6	30	19	6	64·0
1917	15,322	19	13	3	30	0	0	62·2

TONNAGE OF BLENDE IN THE UNITED KINGDOM.

	Tons raised				Mean price of foreign spelter			Ratio % between blende at mines and price of spelter
		£.	s.	d.	£	s	d	
1912	17,704	4	19	2	26	3	3	18·9
1913	17,294	4	0	5	22	14	3	17·7
1914	15,419	3	13	5	23	6	8	15·7
1915	12,057	5	16	10	66	13	1	8·7
1916	8,476	7	14	0	68	8	11	11·2
1917	7,484	10	5	0	52	3	6	19·6

There are no figures available to the public to show the mean percentage of the galena and blende raised, but the galena probably averages 80% lead, and the blende 45% zinc. With the former, the smelters purchased the ore at a fairly even ratio, and the mines have been quite satisfied with the terms. In the case of blende, the position has been different. If the average zinc content is taken at 45%, the smelter purchased ore with the following margins to cover carriage, smelting, smelting losses, and profits:

	Value of zinc in blende £. s. d.	Price paid for blende £ s d	Smelters' margin per ton of ore £. s d.
1912	11 15 4	4 19 2	6 16 2
1913	10 4 5	4 0 5	6 4 0
1914	10 10 0	3 13 5	6 16 7
1915	30 0 0	5 16 0	24 3 2
1916	30 16 0	7 14 0	23 2 0
1917	23 9 6	10 5 0	13 4 6

It is understood that the zinc smelter receives a substantial bonus on output at the present time, but in any case the margin in 1915–16 was enormous, while the blende mines found it impossible to meet the cost of production. The reduction in output is sufficient evidence of the difficulties that have had to be faced.

The total production of 15,322 tons of galena in 1917 was principally from four mines, namely, Weardale Lead Co., Durham; Mill Close mine, Derbyshire; Wanlockhead mine, Lanarkshire; and Leadhills mine, Dumfries. The Welsh output was only 2,002 tons against 12,500 tons in 1900. The Vieille Montagne Zinc Co. at Nenthead, Cumberland, was the largest producer of blende, and their production is the lowest on record.

When the price of galena rose smelters thought there was a chance of stimulating production, but they were soon undeceived. The Government put a maximum on it, and this was subsequently reduced in January, 1918. Since then there has been no increase in price to meet the enormously and steadily increasing costs. In short, production was discouraged and the position was all but hopeless. In September, 1917, the Government issued the Coal Controller's award of 9s., which was applied to lead and zinc miners in January, 1918, equivalent to 1s. 6d. per day at whatever base rate obtained. This was a burden which the mines could not shoulder. However, the Government refunded the January 9s. to those mines which were not making a profit, but stipulated that the mines which were making profits should find the 9s. out of their own resources. Weardale was one of the mines thus victimized. Yet another 9s. was given by the Government in July, 1918, and again this charge had to be met by mines of profit-earning capacity. To those of the mines in a desperate position the refund was still given.

But there were other increased costs, and as the price of lead was fixed, the Government decided to give a bonus to the mines which were unable to bear the costs. The position, therefore, was that if you were losing money you got the bonus; if you were making money you received nothing. That bonus is being given now, and is proposed to be continued until June 30, 1919.

As regards blende, the position is very similar. There is, however, this difference. At the beginning of the war the Government had captured and held enormous supplies of zinc concentrate. They sold this to the smelters at an extremely low price, though at the same time zinc had gone up to a fabulous figure. The smelters could buy zinc concentrate at £4, £5, and £6 per ton from the Government. Naturally they would not give more than the Government price to the home producer. At one time zinc actually soared to £110 per ton. At this price, on the ordinary basis of contract, the mines should have received £25 to £30 per ton for their blende. Ore producers never had an opportunity of retrieving themselves. The Government undersold them all the time. Later on the Government started to buy the Broken Hill concentrate, and mine owners found themselves without a remunerative market. It was only after earnest solicitation and pressure that the Government fixed the maximum price at £11 per ton delivered at the mine, for 50% ore, the owners being at liberty to sell as much above that as possible. Since then, in September, 1918, the price fixed by the Government has been £12. 9s. 9d. for 50% ores delivered at works. This decision, which was taken without consulting mine owners, represents an actual reduction in price in the majority of cases. The September price, it should be stated, is a fixed minimum and maximum. The mines are not allowed to sell any blende to anyone but to the Secretary of the Zinc Smelters' Association, and the market is consequently an absolutely closed one. The terms of this contract, needless to say, are most disadvantageous to any mines raising ores below 50%, as the deduction per unit of zinc contents is fixed at 8s. 5d. With zinc ore at 40% the minimum price under the first arrangement was £9 per ton at the mine. Under the new contract the fixed price of the same ore is £8. 5s. 7d.; the mines having to pay the carriage in the second instance. Further, it has to be noted that although the price of zinc has been increased since this arrangement was made the price of ore has remained stationary.

It is common knowledge that the output of Australia has been purchased by the Government and it is understood that full supplies have been guaranteed to the zinc works for the next ten years. From the point of view of the mine-owners in this country, the only fair thing to-day would be to disclose the terms so that the mines could be in a positon to cope with future developments. The situation is one of great uncertainty.

LABOUR.—Any survey of the general position cannot pass without insistence in the first place that respecting the wages question the refunding of the Coal Controller's award must cease. It is impossible for the mines producing blende to pay the extra charge. The Ministry of Reconstruction, in this connection, it may be stated, has taken the initiative in forming an Industrial Council dealing with the lead and zinc industry, and the preliminary meetings have been held, and a constitution agreed upon. The first formal meeting will be held in the early part of this month. There are going to be all sorts of difficulties between labour and capital, and administrative action will affect the mines at every turn. The Council have made up their minds that they will not discuss such situations as may arise with individual mines, but they will listen to the Whitley Councils. If owners want their industry to have a hearing with the Government it is obviously advisable for them to join the Whitley Councils, and for all the men to be in their Trade Unions. In the case of this Whitley Council the question was whether the metalliferous mines should be joined together. There was a consultation with the Cornish people who decided to have their own Council. The Whitley Council with which owners in this district are connected consists of all the lead and zinc owners, represented by seven members, and all the barytes mines, represented by three members. On the other side are ten representatives of the Trade Unions. The first Chairman of the Council is Mr. A. L. Onslow, the Chairman of the Lead and Zinc Mine Owners' Association. His idea, with regard to this refund, is that the matter must be put to the Industrial Council. What is the use of the Council unless such things can be discussed?

BARYTES.—The price of barytes has risen very rapidly. For crude barytes the price is now £8 per ton compared with 18s. to £1 per ton at the beginning of the war. Mines yielding barytes can of course pay the Controller's award. A good many new properties have been opened out and should come into the producing list very shortly. The possibilities of expansion are chiefly in Shropshire, Flintshire, and Montgomeryshire. There are interesting developments taking place in Scotland, and capitalists are showing more interest in our home mines, which require more substantial backing than they have hitherto received.

LANARK LEAD.—There has been a very fine deposit of ore discovered at Wanlockhead mine in Lanarkshire, where Mr. Mitchell has succeeded in opening out a new lode containing a rich deposit of lead and zinc. The discovery will have the effect of placing the mine, which has had a hard struggle, in the forefront again of English mines.

HEMATITE.—In the hematite iron ore field in the district between Whitehaven and Hodbarrow much interest centres in the sinking and equipment of a new shaft to win the ore in one of the richest discoveries that has been made for many years. The Millom and Askam Hematite Iron Co. has at Ullbank a deposit of ore about 1,000 ft. below the surface. The engineers of the company, judging by the cores brought up from the various bores, report that the ore is of high quality, low in silica, and remarkably free from phosphorus and sulphur. The shaft will be capable of dealing with not less than 5,000 to 6,000 tons per week. In all probability the company will sink a second shaft in another part of the royalty.

CAMBORNE.

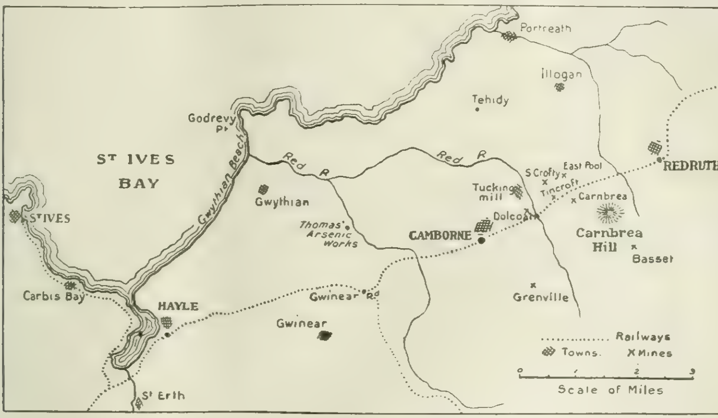
BASSET MINES.—The forecast made in these columns two months since that, unless further capital could be speedily obtained, the end of this undertaking was in sight, has unfortunately proved correct. Toward the close of last year, the pumps were stopped, and the shareholders have since decided to liquidate the company. Under the prevailing conditions and with tin metal at a price less than its pre-war value, there was little chance of attracting fresh capital; there was never at any time justification for the statement made by a contemporary that East Pool & Agar Ltd. contemplated amalgamating with or purchasing the property. This rumour no doubt arose from the fact that Messrs. Bewick, Moreing & Co. examined the mine, presumably in the interests of the owners, the Dolcoath Mine, Ltd., and East Pool & Agar, Ltd., who acquired the mineral rights some time since as part of the Tehidy Estate, and to whom, doubtless, under the lease, the plant had to be offered before a decision could be made to stop operations. There can be no question that war conditions accounted for this failure. Shortage of labour necessitated a reduced output and suspension of development, the latter in turn resulting in a lower grade of ore having to be broken; while the heavy increase in the price of materials, particularly coal, and higher wages both seriously added to the working cost. The drop in the price of tin, following these abnormal conditions, made it obvious to anyone familiar with the financial condition of the company that operations could not long be continued. Those who best know this group of mines believe that they would have well responded to vigorous development, and, given normal conditions and good management, in spite of the heavy incoming water (the pumping charges being about 40% of the total operating cost) a profitable undertaking could have been built up. Operations have been practically confined to the Flat Lode, which has proved exceedingly patchy, and if there can be any criticism of the management, it is that no effort was made before the war to test the other lodes in the property (the West Basset and South Frances sections); while, too, the labour policy of the then manager was hardly calculated to attract miners.

Efforts were made by the Chairman (Major Oats) to secure Government financial assistance, but without success, and this clearly shows that the Government has not yet learnt one of the lessons of the war, that is, the importance of encouraging and assisting metal mining in this country.

It is much feared locally that the closing of Basset will seriously increase the incoming water in the adjoining Grenville mine, although a statement has been made that an examination of the Basset workings does not confirm this view. The Grenville pitwork will certainly not stand any increased load, so it is to be hoped that the official view will prove correct.

CORNWALL TAILINGS.—The accounts of this company for the year ended February 28-1918, show a net profit of £4,192, after allowing £2,000 for depreciation of plant. The tonnage of sand treated fell from 124,471 in the previous year to just under 76,000, while the operating cost rose 1s. to 5s. 2d. per ton, so that but for the improved price for tin during the period under review, the financial result would probably have been unsatisfactory. The profitable parts of the sand dumps at Carn Brea are now practically exhausted, and efforts to acquire further dumps have not been successful, so that the end of this undertaking appears to be in sight; indeed, already some of the plant is advertised for sale. The treatment of these Carn Brea tailings has proved a very profitable business, and credit is due to Mr. Arthur Richards, who inaugurated the undertaking and laid down the scheme of treatment.

TIN TICKETINGS, 1918.—At the 26 fort-



DISTRICT AROUND CAMBORNE AND REDRUTH, SHOWING POSITION OF BASSET.

nightly Ticketings held at Redruth during the year 1918, in all 4,094 tons of black tin was offered for sale, and realized £786,541, or an average price of £192. 2s. 5d. The principal mines contributed to this total as under:

Mine	Tons	Average price £	Value £
East Pool & Agar......	1,280	194	248,855
Dolcoath	819	188	154,384
South Crofty............	564	195	109,846
Grenville	448	183	82,089
Tincroft	382	194	74,037
Basset.....................	301½	194	58,587
Levant	238	199	47,428
Various small mines...	61½		11,315
	4,094	£192	£786,541

The above quantity was purchased by the following smelters:

	Tons
Cornish Tin Smelting Co., Ltd..........	1,141½
Williams, Harvey & Co., Ltd.	1,105
Redruth Tin Smelting Co., Ltd.	689¾
Penpoll Tin Smelting Co., Ltd..........	636½
London Tin Smelting Co., Ltd..........	521¼
	4,094

In 1917, the quantity sold at the Tin Ticketings was 4,186 tons, the value £561,003, and the average price £134.

It is a noteworthy feature that, since the closing down of its Hayle smelter, Messrs. Williams, Harvey & Co., Ltd., at the last four ticketings have only purchased 10 tons. The elimination of the principal buyer obviously lessens the already very limited competition of this so-called tin auction, and the mines would be well advised to figure out the present smelters' returning charges, especially on a falling market, and calculate whether it would not be more profitable to make a fixed contract.

MINERAL STATISTICS, 1917.—The belated official statistics show that the black tin production of Cornwall and Devon for the year 1917 amounted to 6,576 tons, having a monetary value of £784,493. This is a reduction of 1,317 tons on the 1916 output, but the value is £72,351 higher, owing to the better prices obtained, the mean monthly price of standard tin on the London Metal Exchange for 1917 being £237. 13s. 1d. From the returns of the owners of mines and quarries, it would appear that the percentage of metallic tin obtainable in the case of ordinary ores was 65·6, while in the case of the produce from so called "streamworks" the average percentage obtainable was 32·7. No details are furnished of the production of the individual mines, as was given prior to the war, the reason advanced being pressure of work occasioned by the war. This excuse is a little "thin," as to secure the totals these details were necessary, and the value of the statistics is much depreciated by their absence.

In the case of wolfram, 205 tons was obtained from Cornwall and 4 tons from Devon, valued respectively at £35,381 and £789. The average percentage of metal contained in the dressed ores from the former county was 62·75.

For some unknown reason, the output of arsenic and arsenical pyrites from Cornwall and Devon is not specifically given. The total production of arsenic from the United Kingdom was 2,626 tons valued at £146,031, and it may be assumed that well over 90% of this output came from Cornwall and Devon, seeing that the previous year (vide the report of Sir Lionel Phillips referred to in the last issue) the output from these counties was 2,534 tons. Arsenical pyrites produced in the United Kingdom amounted to 434 tons, valued at £2,599.

The output of dressed copper ore from Cornwall was 617 tons, having a value of £5,492.

The number of persons employed in the tin-mining industry of Cornwall and Devon was 5,053, of whom 2,493 were employed underground and 2,560 at surface. In 1912, the number employed was 8,065.

JOINT INDUSTRIAL COUNCIL.—We understand that at last the draft constitution of this council has been approved by all parties on the preliminary committee, and also by the Ministry of Labour. The delay has been due to difficulty in arranging the representation of the different Labour Unions concerned. However, once the permanent committee has been appointed, it may be safely assumed that under the active leadership of Mr. C. A. Moreing (who will be the first chairman) the many important matters which await the consideration of the council will be tackled with vigour. Two of immediate importance are demobilization, and State assistance for the industry. As regards the former, only a few days since the Ministry of Labour stated that "the help of associations of masters and men (that is, Joint Industrial Councils) in advising the Department as to the key factors of the situation in each particular trade is being looked for." The only hope for getting miners and others promptly out of the services is for the matter to be handled by people who know the needs and condition of the industry. It is obvious that no Government Department is equal to doing more than issue forms and directions.

On the question of State assistance for the industry, it is probably no secret that shortly a deputation representing both employers and employed will wait on the Government to press for an inquiry as recommended by the Committee of Production and referred to in these columns in November last. While the State may reasonably be asked to assist the mines during the continuance of the existing abnormal conditions, caused by the needs of the State, we do hope that State control will be strenuously opposed, unless, indeed, the State is prepared to take over the mines at a valuation and become entirely responsible for their management. If we may judge by the recent experience of Basset, a good deal of spade work has to be done before financial State assistance becomes practical politics. However, we firmly believe that if any success is to be attained in this direction it will only be through the Joint Industrial Council, and we are glad to recall therefore that the establishment of such a Council was first advocated in these columns as long ago as November, 1917.

Priority of Plant.—The Ministry of Munitions has recently announced the sale of machinery and plant which has been used for the purposes of war. Representations have now been made to the Ministry by the Cornish Chamber of Mines that industries—such as tin mining—producing raw materials of service in the reconstruction of the country's trade should have priority in the purchase of this plant. We believe, too, that at last representations have also been made to the Government Department concerned as to priority for the industry in the supply of certain materials, which are limited in quantity, but essential for mining.

The Mining Division.—Although the Cornish Chamber of Mines went to much trouble, at the time the Parliamentary constituencies were being re-arranged under the People's Representation Bill, 1917, to secure the retention of the Mining Division as a separate entity, it is evidence of the lack of leadership in the mining industry that no candidate was put forward to fight the constituency in the interest of the industry. With Liberals and Labour at each other's throats, it would have been a comparatively soft thing for an independent candidate making Cornish mining affairs the chief plank in his platform, for he would have rallied around him a large proportion of the 59% of electors who did not trouble to go to the poll; while also many of those who voted either Liberal or Labour would doubtless have supported a candidate who was connected with the industry, and who undertook to voice its wants in and out of Parliament. It was a good opportunity lost. However, the successful candidate, Mr. F. D. Acland, did, under pressure, pledge himself to support "State responsibility for the mines," and this is a good illustration of what election pressure will do to change a candidate's views, for, as has been remarked before in these columns, he has previously said publicly that tin mines which cannot pay wages equivalent to the extravagant war wages of the colliers should be closed down. As the question of Government assistance for the industry is likely to be much to the front in the near future, the co-operation of Mr. Acland may be of some service.

LETTER TO THE EDITOR

The Magnetic Needle in Mine Surveying.

The Editor:

Sir—Mine surveyors in Cornwall should be exceedingly grateful to Mr. L. H. Cooke for his article published in your September issue. On account of cramped vertical shafts, steeply - inclined shafts, and compound shafts, orientations by plumbing methods are so seldom applicable, that the Cornish mine surveyor has frequently to depend upon the magnetic needle for the carrying of the meridian underground.

The values, as now published, of the mean magnetic declination from the smoothed curves of Kew Observatory are certainly instructive, inasmuch as they throw a clear light on the diurnal fluctuations to which the magnetic needle is subject. Even in their present form they are of practical utility to the mine surveyor, as they permit of the magnetic orientation of an underground survey with a greater degree of accuracy than was possible previous to their publication. Their value, however, would be considerably enhanced if the Meteorological Office would publish in the future either the actual curves or exact values of declination given at every half hour. I wish, therefore, to join with Mr. Cooke in the plea that in the near future the Meteorological Office will accede to this request, and thus confer upon mine surveyors what will undoubtedly prove a great boon.

Frederick Winiberg,
Instructor in Mine Surveying.

School of Metalliferous Mining,
Camborne, December.

PERSONAL.

HENRY BAILEY is now with the Thermo-Electric Company, Limited, at Luton, Bedfordshire.

C. RAYMOND BERINGER has returned to Camborne. He was metallurgist at a tin-smelter in Hungary and was held as a civil prisoner throughout the war.

CHARLES P. C. BERESFORD, manager of the Prestea Block A, is returning to West Africa.

D. A. BREMNER has been appointed director of the British Engineers Association, and will be the chief organizing and executive officer of the association.

CECIL L. BUDD, of the firm of Vivian, Younger & Bond, has been made a K.B.E.

E. H. BULMAN has resigned the management of the New Kleinfontein mine.

MAJOR A. R. CANNING is leaving for Nigeria.

JEROME J. COLLINS is engaged on construction work for the Electro Bleach & By Products Company, Limited, at Middlewich, Cheshire.

J. C. FARRANT, London representative of the Hardinge Conical Mill Company, has returned to England after having been a prisoner of war in Germany for over four years.

W. R. FELDTMANN has returned from a periodical visit to the mines of the Ashanti Goldfields Corporation, West Africa.

CAPTAIN J. G. FOLEY, who was with the Rayfield Company, and joined the Cameroons force, has received the Military Cross, with a bar.

JOHN A. P. GIBB, consulting engineer to the Anglo-French Exploration Company, has returned to South Africa.

W. H. GOODCHILD is leaving for Cuba.

W. L. HONNOLD is here from New York, and will in future reside in Paris.

T. J. JONES has left for Russia.

CAPTAIN A. H. MOREING, son of C. Algernon Moreing, and partner in the firm of Bewick, Moreing, & Co., has been elected Member of Parliament for the Buckrose division of the East Riding of Yorkshire as a Coalition Unionist. He scored 9,310, against Labour 3,178, and Liberal 2,792. He was on the Western Front throughout the war, and served on Sir Julian Byng's staff.

JOHN W. MOULE has left Great Cobar to take the position of assistant manager for the Burma Corporation at Namtu.

C. HOPE NICOLSON has left for Nigeria.

LT.-COL. P. W. NISSEN is home from France.

MAJOR H. G. PAYNE, D.S.O., is home from France.

W. PELLEW-HARVEY has left for Australia.

G. B. REYNOLDS and T. BRUCE MARRIOTT have gone to British Guiana on an oil investigation.

WILLIAM RUSSELL, London representative of the Dorr Company, has left on a short visit to the United States.

F. F. SKURRAY will be leaving for Nigeria shortly.

J. E. SNELUS is returning to Nigeria.

A. B. SNOW is returning to Burma from the United States.

S. J. SPEAK is going to Rhodesia this month.

E. GYBBON SPILSBURY has been appointed to represent the American Institute of Mining Engineers at the Engineering Congress in Paris. The delegation from the United States, invited by the French Government, is composed of members of the four national engineering societies. The delegation sailed on December 5 and expect to be away about six weeks.

DR. A. W. STICKNEY has returned to London from Cyprus.

NORMAN C. STINES was in London for a few days on his way from Russia to France.

AUBREY STRAHAN, director of the Geological Survey, has been created a K.B.E.

W. E. THORNE is here from the United States, and expects to leave for Nigeria shortly.

E. B. THORNHILL has been appointed research engineer for the Chino Copper Company, New Mexico.

PALMER CARTER, manager of the Robinson gold mine on the Rand, died suddenly last month.

OSMER B. WARD, lately manager of the Block 10 mine, Broken Hill, and of the Misima gold mine, died in August last. He took his A.R.S.M. in 1897 and for a dozen years was with Bewick, Moreing, & Co. in West Australia, his last appointment there being manager of the Lake View Consols.

SHERMAN H. BORIGHT died on the Lonely mine, Rhodesia, on November 2, of influenza complicated with pneumonia. He was born in Canada in 1881, and was trained at McGill. He went to South Africa in 1905, where he was engaged continuously in mine management up to the time of his death, in particular being identified with the development of the Lonely Reef Gold Mining Company from its earliest days. He was a member of the Executive Committee of the Rhodesia Chamber of Mines and was one of the most active members of the mining community of Southern Rhodesia.

PIERRE DE PEYSTER RICKETTS, who died on November 20, aged 70, was for over thirty years a member of the teaching staff of the Columbia School of Mines, New York. He was a partner in the distinguished firm of consulting metallurgists, Ricketts & Banks. Born in Brooklyn, he studied at Columbia, graduating in 1871, and receiving the degree of Ph.D. five years later. In 1885 he was appointed professor of assaying, and in 1913 professor of analytical chemistry and assaying. His book, "Notes on Assaying," was one of the first on the subject published in America, and it was widely used in the colleges there.

ERNEST GORDON SUDLOW, manager of the Government Gold Areas mine in the Far East Rand, died in September. Mr. Sudlow was born in Manchester thirty-four years ago, and his early death has cut short a most promising career. He went to South Africa in December, 1906, after completing his education at the Royal School of Mines, London, of which he was an associate. He commenced his mining career on the New Goch mine as a post-graduate student, and subsequently, after a short stay in Rhodesia, he accepted a position on the Brakpan. After many years on this property in its developing stages, he rose to the position of underground manager, and left in 1913 to take up the position of assistant manager of the Consolidated Langlaagte Mines. In September, 1915, he was transferred to a similar position on the Government Gold Mining Areas, and in January, 1917, he was appointed general manager.

CHARLES E. WATSON, while returning on the steamer Princess Sophia from a visit to Alaska on business for the Mining Corporation of Canada, was drowned when that ill-fated vessel foundered off the Pacific Coast in Lynn Canal, on October 25. Mr. Watson was born in Cleveland, Ohio, on February 6, 1880. After graduating at the School of Mines, Columbia University, as a mining engineer in the year 1902, he went to Butte and worked in the properties of the Amalgamated Copper Co. for a couple of years, and then went to Africa. He spent several years on the Rand, directing underground operations at some of the mines, among others the Simmer & Jack, the Rose

Deep, and others. Returning to the United States, he took charge of properties in Arizona, and later went to Mexico. From there he went to Cobalt in 1908, where he was employed at the Nipissing, and later became manager of the Chambers-Ferland mine. From Cobalt he went to Porcupine to direct the development of the Dobie and also of the Plenaurum mines From Porcupine he returned to Cobalt to assume the management of the Townsite mine and, after the amalgamation, became manager for the Mining Corporation of Canada. Under his direction the company grew from a comparatively unimportant concern into one of the largest mining companies in Canada.

DR. HARRY P. CORLISS, chemical and metallurgical engineer with the Metals Recovery Company, died on November 16, at the age of thirty-two years, at Ray, Arizona. His death was the result of pneumonia following influenza. In 1910 Dr. Corliss received the degree of Bachelor of Science in Chemical Engineering at New Hampshire State College. He then continued his studies at the University of Toronto for two years, specializing in physical and organic chemistry. At the end of this time he accepted a position as industrial fellow in the Mellon Institute of Industrial Research, Pittsburgh. In 1913 he received the degree of Doctor of Philosophy at the University of Pittsburgh. Dr. Corliss' work at the Mellon Institute extended over a period of five years. During most of his time he was engaged in research upon metallurgical problems. The research resulted in several important improvements upon the flotation process. Perhaps his most notable contribution to this industry was his discovery of alpha-naphthylamine as a flotation agent. In 1917 he accepted a position with the Metals Recovery Company in order to initiate the large-scale application of his discoveries. In this work he was uniformly successful and was rapidly making for himself an enviable reputation as a metallurgical engineer when death called him.

THE LATE LORD FORREST.—The *Geographical Journal* for December, the organ of the Royal Geographical Society, prints the following appreciation of the late Lord Forrest in his capacity as explorer in West Australia: Born in 1847 in the Colony with which his whole life was associated, John Forrest entered the Survey Department of Western Australia, and when only twenty-two led his first expedition into the unknown interior. It was sent out by the Government in 1869 for the purpose of testing the reports of natives that remains of murdered white men had been seen in the interior, reports which it was suggested might refer to members of the lost Leichardt expedition. No trace of such remains was discovered, but in pushing east to 122° 50′ E. long. some good country was met with, though the larger part was useless scrub-covered land with extensive salt marshes, Lake Barlee and others. In 1870 Governor Weld commissioned Mr. Forrest to organize an expedition from West to South Australia, through the country at the head of the Great Australian Bight, known only in the immediate neighbourhood of the coast through the painful experiences of Governor Eyre during his great journey through this region in the reverse direction. Profiting by Eyre's map and descriptions the expedition was successful, Adelaide being reached without mishap in five months. A good deal of new country was examined, and important results ensued in the settlement of the Eucla district, and the construction of a telegraph line connecting Western Australia with Adelaide and so with the general telegraph system of the world. But the whole western interior of Australia from the outskirts of settlement in the west to the telegraph line in the centre was still quite unknown, and a new task awaited Forrest in carrying a line from west to east across the heart of this area, by which feat, in conjunction with the journeys of Warburton and Giles, a knowledge of its true character was gained for the first time. Forrest's new expedition set out early in 1874, just after the news of Warburton's success in reaching the west coast from the telegraph line had been received. The experiences of Warburton, who, provided though he was with camels, had only got through the desolate wilderness after the most arduous and harassing struggle, were not encouraging, but there was a hope that in a more southerly latitude the conditions might be more favourable. Pushing inland by way of the Murchison the party found travelling easy and pleasant until the watershed was reached in about 120° E. Thenceforward the difficulties surpassed all expectation, the travellers entering a spinifex desert which extended with hardly a break for 600 miles. The country was wretched beyond belief, and for week after week its fearful monotony was but rarely broken by grassy valleys of small extent. One oasis was found at Weld Spring, in long. 121° 21′ E., which offered a pleasant halting-place, and at last by the middle of August the hilly country already reached by Gosse and Giles from the east was sighted, and in spite of further difficulties from the unusual drought the Peake Telegraph Station was gained on September 30. The total distance travelled, mostly on foot, was 2,000 miles. In presenting the Patron's Medal of the Royal Geographical Society to the explorer in 1876 the President expressed the opinion that, since Macdouall Stuart's traverse of Australia from south to north in 1860, no journey of the same magnitude and difficulty had been accomplished as that of John Forrest and his party, and never had a more conscientious and exhaustive survey of the route traversed been executed.

TRADE PARAGRAPHS

THE AMERICAN ZINC, LEAD, & SMELTING CO., of St. Louis and New York, send us a booklet giving information relating to their zinc oxide pigments. The company commenced this manufacture in 1917 at their spelter and acid plant at Hillsboro, Illinois. The trade name of the brands is "Azo," and the pigments are made in three grades The first is 99·2 to 99·8% zinc oxide; the second 94 to 96%, with 3 to 6% lead sulphate; and the third 89 to 91%, with 8 to 10% lead sulphate. The booklet specifies the quality, characteristics, and uses of the three grades. A great deal of information useful to the makers and users of paints is given in the booklet, relating to the analysis of pigments, the tinting and oil-absorption of pigments, mixing, grinding, thinning, characteristics of oils, varnishes, resins, etc.

DICK, KERR AND CO., Limited, of Preston, and London, have recently received an order for two 5,000-kilowatt turbo-alternator sets and condensing plants for the Union Minière du Haut Katanga. The turbines will be of the Willans-Zoelly type, and will operate on steam at 145 lb. per square inch pressure. They are to carry an overload of 6,250 kilowatts for two hours. The condensing plants, which are to maintain a vacuum of 28 in. with a barometer of 30 in., are each designed to deal with 66,000 lb. of exhaust steam per hour, and have 10,000 square feet of cooling surface. The turbines will be coupled to Siemens alternators designed for a normal output of 5,000 kilowatts at 0·9 power factor (5,560 kilovolt-ampères) when supplying three phase current at 50 cycles and 6,600 volts pressure, and are to be capable of carrying overloads of 25% for two hours, or 50% momentarily. The ventilating air for these machines will be filtered in dry air filters of the Premier Cooler Company's make The machines will each be fitted with a direct coupled 110-volt exciter of the overhung type, and will operate in conjunction with an automatic voltage regulator. The firm of Dick, Kerr & Co. has recently been amalgamated with others to form the ENGLISH ELECTRIC COMPANY, LIMITED.

THE DENVER ENGINEERING WORKS COMPANY.—Since Mr. H. W. Hardinge, of the Hardinge Conical Mill Company, acquired a considerable interest in this company, some changes have been made in the administration. Mr. R. B. T. Kiliani, secretary and treasurer of the Hardinge company, has been elected vice-president and treasurer of the Denver company, and is a director of that company. He will be located in the office of the Hardinge company, First National Bank Building, Denver. Mr. V. A. Stout, sales engineer, has removed his office from San Francisco, and will be in charge of the Salt Lake office of the Hardinge company. With him will be associated Mr. W. L. Penick, who was formerly with the Granby Consolidated Mining & Smelting Company, of Anyox, B.C. Mr Penick has been acting as sales engineer for the Hardinge company for several months and has been very successful. Mr. Stout recently succeeded in obtaining an order from the Santa Gertrudis Company in direct competition with several other manufacturers. Mr. Lewis Searing has resigned as vice-president of the Denver company to go east, and his position has been filled by Mr. W. W. Torrence, formerly with the General Electric Company in Denver. Mr. Alfred Tellam, formerly metallurgical engineer and superintendent at the plant of the Ridder Mining Company of Siberia, is in charge of the engineering work connected with the sale of milling equipment. Mr. Kiliani will handle all the sales business for the Denver company in so far as it relates to milling equipment.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., LTD., of Cambridge, send us a pamphlet describing their electrical distance thermometers. These are suitable for the measurement of all temperatures from minus 300° to plus 1,000°F., and may be read at selected positions any desired distance from the source of heat. In power plants, heating and ventilating schemes, chemical works, explosive factories, etc., it is frequently a great advantage to read from a single instrument the temperatures in various parts of the building or plant. The convenience of a centralized scheme of this kind is at once apparent where a number of temperature readings have to be observed in different and often inaccessible positions. Regardless of the distance between the thermometer and the instrument the accuracy of the readings can be confidently relied on, while on account of the thermometers being constructed entirely of metal and also strongly armoured, breakages are rare and the maintenance charges practically nil. Consequently, increased control and resultant efficiency are obtained. The principle upon which these thermometers are based depends on the fact that the electrical resistance of a platinum wire changes with its temperature according to a well known law. The resistance of the thermometer wire is compared with known resistances, which are arranged to form a Wheatstone bridge in the indicator case. Any alteration in the resistance of the platinum coil causes a deflection of the galvanometer needle over a scale directly calibrated in temperature. A two or four-volt accumulator is used to work the system according to the range required, and as the electrical energy consumed is exceedingly small, the accumulators only need re-charging at long intervals. The company have recently supplied a large distance thermometer outfit comprising a 4 point recorder, two 30 point indicating switchboards, two 20 point indicating switchboards, and the necessary resistance thermometers, to the St. John Del Rey Mining Co, Brazil. This outfit is being used for taking temperatures in a refrigerating plant used in connection with the ventilating system of the mine.

THE BRITISH THOMSON-HOUSTON CO., LD., of Rugby, have recently designed a turbo-blower set for blast-furnaces, which can be driven either electrically or by steam-turbine, the object being to provide against any possible interruption to the supply of air. The unit consists essentially of a synchronous motor driving the blower, this motor being operated in addition as a power factor adjuster on a 3,000 volt 50 cycle supply. A turbine of the Curtis type is also included, to provide against failure of current to, or breakdown of, the synchronous motor. The fact that maintenance of a continuous blast is essential made it necessary to provide clutches, between the synchronous motor and the blower, and between the turbine and the blower, of a type that would be self-engaging and disengaging (while running) in case of failure of current or breakdown of the driving motor, so that the turbine could be clutched to the blower shaft in order to carry on the drive in place of the motor. Moreover, such a change over of the driving medium can take place automatically in the absence of attendants from the engine-room. In view of the fact that the normal speed of operation of the set when driven by the synchronous motor is 3,000 r.p.m., and that the change-over from synchronous motor drive to turbine drive must take place while running, it is obvious that the design of the clutches to meet these conditions required a considerable amount of attention. There are numerous existing clutches of the friction-operated type which will meet the conditions of engagement, but the question of disengagement automatically, and particularly at high speeds of rotation, is a condition that cannot be met by a friction clutch of the ordinary type. It is claimed, however, that these conditions have been successfully met in the design of the clutch which has been evolved for the driving of this unit. For starting up the turbine in case of a failure of current or breakdown of the motor, there is provided on the turbine steam-supply main a special balanced valve, the opening or closing of which is controlled by the delivery air pressure of the blower. Under normal conditions, the blower is driven by the synchronous motor, which at the same time is operated as a power-factor adjuster on the supply system. In running the set up, the synchronous motor is started as a squirrel-cage induction motor, the clutch between the motor and blower engaging as soon as the synchronous-motor rotor commences to revolve. When the motor reaches practically synchronous speed, it is paralleled by closing the field switch of the motor rotor circuit, and then operates as a synchronous motor with all the attributes of a power factor adjuster. The delivery air pressure of the blower holds the starting valve for the turbine closed, so that the turbine cannot run under normal conditions of operation. If failure of current supply to the motor, or a breakdown, should occur at any time, the set commences to slow down in speed with a consequent fall in air delivery pressure; the starting valve on the turbine then opens up, running the turbine up to speed, and at the same time the clutch between the turbine and blower engages itself as soon as the turbine and blower shafts reach the same speed. This occurs with a small drop in air pressure. The blower is then driven by the turbine, and the synchronous motor rotor automatically disengages itself and comes to rest. Owing to the type of friction clutch provided, the change over from motor drive to turbine drive takes place without shock; in fact, it is said to be almost impossible to detect the moment of engagement, although the speeding up of the turbine is extremely rapid, as also is the deceleration of the blower shaft.

METAL MARKETS

COPPER.—The month just past has been the most interesting, because the most eventful, in the copper market for a very long time past. By reason of its great importance as a war metal, copper has of necessity been under very close control during the past few years, and as a natural result the market as such had really ceased to exist. Official prices were the basis of transactions, dealings were only carried on under official auspices, and although closing prices of standard were quoted daily, the market for this commodity was in reality entirely suspended on 'Change. However, with the welcome cessation of hostilities in the world-war, a new era was at once looked for, or rather a resumption of the old, and almost forgotten, practices of peace-time. Metal dealers whose business had been sadly curtailed by the exigencies of war, naturally eagerly anticipated a return of normal trading and warmly welcomed the announcement made about the middle of December of the suspension of the controlling orders in regard to copper. This in effect left the market free and entirely to its own resources. In making the intimation the Government at the same time published particulars of the stocks held by the Minister of Munitions in this country on December 1. In the case of copper these amounted to 27,530 tons. The policy of the authorities in taking the trade into its confidence on this point can only be commended, removing as it does apprehensions regarding what the unknown stocks might be. It is further intended to publish at monthly intervals the stocks held on the first of each month. The figures mentioned, of course, do not include old metal and scrap, and it is understood that large quantities of scrap, mainly brass, are also in existence.

The immediate effect of the release of the metal from control was the reopening of the standard market, and tentative attempts were made to start dealings again. As was to be expected, ideas of buyers and sellers were at first pretty wide apart, but the general effect was to reduce values. These subsequently recovered somewhat, the first transaction being at £100 three months, but the value of that position has since declined again. Refined copper was slower to feel the effects of the new conditions, but it also later eased off. Business in this grade of the metal is slow to develop, partly doubtless owing to the fact that a little time is required to get industries turned from a war to a peace footing. In addition, the holiday period is always a deterrent to business. Apart from that, however, there was naturally a slight lack of confidence in the future of prices. This was doubtless owing to the position in the United States The official price in that country continued to rule at 26 cents, but in spite of this, transactions were reported to have taken place as low as 19 cents. Probably this was largely due to smaller producers cutting prices, but there was evidently a feeling of uneasiness due to the cessation of war demands, while at the same time output was on a large scale. There since appears to be rather a firmer feeling there, and as price control finishes with the end of the year, the market will be left to establish itself on the basis of its intrinsic merits.

Copper ores containing from 15% to 25% copper are valued for around 22s. to 24s. per unit according to quality. The demand is good.

Average prices of cash standard copper: December 1918, £116. 5s.; November 1918, £122 5s; December 1917, £110. 5s.; November 1917, £110. 5s.

Our imports for January to November were 191,737 tons, including 125,645 tons from the United States, against 123,511 tons (65,091 tons from the United States) the year before.

TIN.—The market for this metal has, during the past month, like that of copper, been signalized by the suspension of the controlling orders. Of course, the restrictions in regard to this metal were never of so close a nature as those applying to some of the other metals. Tin is not, for example, quite so important from the war point of view as copper and lead, and indeed it was not until comparatively late in the war period that it was found necessary to bring it under control. Even when this was done the market for tin on the Metal Exchange still remained open, dealings, however, being carried on under supervision, while users were rationed. Therefore, the suspension of controlling orders in regard to this article was perhaps not quite so far-reaching an event as in the case of copper. Nevertheless, the withdrawal of restrictions was received with gratification. The general tendency of prices throughout the month has been downward. At the end of November the value of cash tin was £285, while immediately at the beginning of December £10 was knocked off this figure, and by December 19 the price had reached £254. A reaction ensued to £266, but subsequently values came down to £235. 10s. cash and £229. 10s. three months.

Business in tin in the open market has undergone a considerable expansion during the past few weeks, and with the possibility of an early re-appearance of statistics, and with particulars available once more as to

Daily London Metal Prices: Official Closing Prices on Copper, Lead, Zinc, and Tin per Long Tons; Silver

	Silver	Copper				Lead
		Standard Cash	Standard (3 mos.)	Electrolytic	Best Selected	Soft Foreign
Dec.	d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
1	[illegible]	111 10 0 to 112 10 0	111 10 0 to 112 10 0	125 0 0 to 123 0 0	123 0 0 to 121 0 0	40 10 0 to 39 10 0
13	[illegible]	111 10 0 to 112 10 0	111 10 0 to 112 10 0	125 0 0 to 123 0 0	123 0 0 to 121 0 0	40 10 0 to 39 10 0
16	[illegible]	111 10 0 to 112 10 0	111 10 0 to 112 10 0	125 0 0 to 123 0 0	123 0 0 to 121 0 0	40 10 0 to 39 10 0
17	[illegible]	111 10 0 to 112 10 0	111 10 0 to 112 10 0	125 0 0 to 123 0 0	123 0 0 to 121 0 0	40 10 0 to 39 10 0
18	[illegible]	100* 0 0 to 101* 0 0	80* 0 0 to 90* 0 0	125 0 0 to 123 0 0	123 0 0 to 121 0 0	40 10 0 to 39 10 0
19	[illegible]	111 10 0 to 112 10 0	95 0 0 to 105 0 0	125 0 0 to 123 0 0	123 0 0 to 121 0 0	40 10 0 to 39 10 0
20	[illegible]	111 10 0 to 112 10 0	95 0 0 to 105 0 0	125 0 0 to 123 0 0	123 0 0 to 121 0 0	40 10 0 to 39 10 0
23	[illegible]	111 10 0 to 112 10 0	99 10 0 to 100 10 0	122 0 0 to 120 0 0	123 0 0 to 121 0 0	40 10 0 to 39 10 0
24	[illegible]	111 10 0 to 112 10 0	99 10 0 to 100 10 0	122 0 0 to 120 [illegible] 0	120 0 0 to 118 0 0	40 10 0 to 39 10 0
30	[illegible]	111 10 0 to 112 10 0	85 0 0 to 86 0 0	122 0 0 to 120 0 0	120 0 0 to 118 0 0	40 10 0 to 39 10 0
31	[illegible]	111 10 0 to 112 10 0	87 10 0 to 88 10 0	122 0 0 to 120 0 0	120 0 0 to 118 0 0	40 10 0 to 39 10 0
Jan.						
2	[illegible]	111 10 0 to 112 10 0	87 10 0 to 88 10 0	122 0 0 to 120 0 0	120 0 0 to 118 0 0	40 0 0 to 35 0 0
3	[illegible]	111 10 0 to 112 10 0	88 0 0 to 89 0 0	122 0 0 to 120 0 0	118 0 0 to 116 0 0	40 0 0 to 35 0 0
6	[illegible]	91 0 0 to 93 0 0	86 0 0 to 88 0 0	[illegible] 0 0 to 112 0 0	118 0 0 to 116 0 0	40 0 0 to 35 0 0
7	[illegible]	95 0 0 to 96 0 0	86 0 0 to 88 0 0	105 0 0 to 103 0 0	103 0 0 to 101 0 0	40 0 0 to 35 0 0
8	[illegible]	95 0 0 to 96 0 0	87 0 0 to 88 0 0	105 0 0 to 103 0 0	103 0 0 to 101 0 0	40 0 0 to 35 0 0
9	[illegible]	95 0 0 to 96 0 0	85 0 0 to 86 0 0	105 0 0 to 103 0 0	103 0 0 to 101 0 0	40 0 0 to 33 0 0

* Nominal

values ruling in the East, the market is once more assuming something like its normal appearance. A moderate consuming trade is moving, but in this there is room for improvement, tinplate works, while finding a good demand for their product, being handicapped by lack of labour. As men get released from the forces, however, this difficulty should rectify itself.

As regards America, the whole position there is somewhat peculiar. Under the Inter-Allied Tin Control, the United States made claim to a pretty large proportion of the available supplies. In doing so, it almost appears that she has over-estimated her requirements, or perhaps under-estimated the stocks already in that country. At all events an official price has been fixed there at about the parity of £340 per ton, and it is believed in some quarters that this figure—much above the value ruling here—has been fixed to enable the stocks now held in the United States to be liquidated. These are thought to be considerable, so that country can hardly be expected to be a customer in this market yet awhile. Values in the Straits Settlements at first showed resistance, and were maintained rather above London parity. Latterly, however, weakness set in and a sharp decline took place.

Average prices of cash standard tin: December 1918, £267. 14s. 3d.; November 1918, £317. 7s. 7¾d.; December 1917, £298. 10s. 3d.; November 1917, £275. 2s. 10d.

Our imports for January to November were 11,750 tons, against 25,624 tons in 1917.

SPELTER.—The controlling orders in regard to this metal were also suspended during the past month, and the market was left free to develop itself. At the same time the stocks held by the Ministry of Munitions in this country as at December 1 were also published. These amount to 18,678 tons of G.O.B,. and 6,544 tons of refined. On the withdrawal of control some efforts were made to re-establish dealings on 'Change, but the market has remained steady at £56 to £52. A moderate demand has been experienced, but as galvanizers are getting their baths going again, it expected that a good inquiry will eventually come along, particularly as there seems room for an excellent demand for the product of the galvanizing works. The American market has been weak, evidently chiefly on the cessation of the war demand, and values there of spot metal have declined during the month from 8·40 cents to 8 cents. It is stated, however, that values ruling there are below cost of production, so that the falling tendency cannot be expected to continue indefinitely.

Average prices for good ordinary brands: December 1918, £54; November 1918, £52. 7s. 7¾d.; December 1917, £52; November 1917, £52.

Our imports for January-November were 58,315 tons, compared with 68,051 tons in 1916.

ZINC DUST.—Australian (88 to 92%) £105 to £107 per ton; English (70 to 75%) £90 ton.

LEAD.—This was another of the metals which has enjoyed release from the controlling orders during the past month, and efforts have been made to establish dealings on the Metal Exchange again in this article also. So far any effect on prices has not been apparent, however, values having remained steady with the official price unchanged at £40. 10s. to £39. 10s. net. While making the announcement in regard to suspension of controlling orders the Government also stated that the stocks held by the Ministry of Munitions in this country on December 1 of soft pig-lead were 49,111 tons. This quantity is not considered by any means heavy as a surplus stock. There is, however, obviously enough to go round. A good demand is anticipated for manufactured lead, and inquiries for export have already been seen in the market, not to mention inquiries for export of pig-lead itself.

The American market has been weak, the Trust price having been reduced to 6 cents, while there appear to be sellers at even less. Bids have been solicited from this side, but no reports are current of any business having been effected. Japan was also at one time reported to be a seller, presumably of Australian lead, in which she apparently was overbought.

Our total imports for January to November were 194,081 tons, against 133,609 tons in 1917.

Average net prices for soft foreign lead: December 1918, £40; November 1918, £31. 12s. 4¾d.; December 1917, £30 gross; November 1917, £30 gross.

ANTIMONY.—This market has not been interesting during the past month. While the official price of British regulus was quoted at £80, foreign material in warehouse ruled at considerably less money, and could doubtless be bought in the neighbourhood of £60. Buyers have been shy, however, and there appears to have been little trade moving. It is reported that the Government stocks amount to 3,300 tons, which under peace conditions it will take some time

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter)	Standard Tin, Cash	Standard Tin, 3 mos.
£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
56 0 0 to 52 0 0	274 10 0 to 275 10 0	269 0 0 to 270 0 0
56 0 0 to 52 0 0	274 0 0 to 275 0 0	269 0 0 to 270 0 0
56 0 0 to 52 0 0	271 10 0 to 272 10 0	269 0 0 to 270 0 0
56 0 0 to 52 0 0	269 10 0 to 270 0 0	268 10 0 to 269 0 0
56 0 0 to 52 0 0	260 0 0 to 261 0 0	256 10 0 to 257 [illegible] 0
56 0 0 to 52 0 0	253 10 0 to 254 0 0	245 0 0 to 246 10 0
56 0 0 to 52 0 0	264 0 0 to 265 [illegible] 0	254 0 0 to 255 0 0
56 0 0 to 52 0 0	266 0 0 to 266 10 0	254 0 0 to 254 10 0
56 0 0 to 52 0 0	264 0 0 to 264 10 0	256 0 0 to 256 10 0
56 0 0 to 52 0 0	250 0 0 to 251 0 0	243 0 0 to 244 [illegible] 0
56 0 0 to 52 0 0	235 0 0 to 236 0 0	229 0 0 to 230 0 0
56 0 0 to 48 0 0	235 0 0 to 235 10 0	230 10 0 to 231 0 0
56 0 0 to 48 0 0	236 0 0 to 236 10 0	231 10 0 to 232 0 0
56 0 0 to 48 0 0	241 0 0 to 241 10 0	236 0 0 to 236 10 0
56 0 0 to 48 0 0	256 0 0 to 256 10 0	247 10 [illegible] to 248 0 0
56 0 0 to 48 0 0	257 0 0 to 257 10 0	247 10 0 to 248 0 0
56 0 0 to 45 0 0	255 0 0 to 255 10 0	246 10 0 to 247 0 0

to use up. Toward the end of the month the official price of British regulus was reduced to £55.

ARSENIC (White).—This market has been flat and latest prices are around £90 to £93.

BISMUTH.—12s. 6d. nominal per lb.

CADMIUM.—8s. to 9s. per lb

ALUMINIUM.—£200 per ton d/d to home consumers.

NICKEL continues at £195 for the home trade.

PLATINUM.—New 400s. per oz.; old 340s. per oz.

PALLADIUM.—500s. per oz. nominal.

QUICKSILVER.—Export prices are about £20 to £21.

SELENIUM.—18s. to 20s. per oz.

TELLURIUM.—90s. to 105s per oz.

SULPHATE OF COPPER continues at about £60 net f.o.b for export, and £52 for home trade. The market is idle.

MANGANESE ORE.—Indian ores are still nominal at 3s. 6d. to 3s. 7d. per unit c.i.f. U.K.

WOLFRAM ORE.—65% WO_3 is quoted officially at 60s. per unit for Empire material, which suffices for all requirements; the official figure for ferro-tungsten is 6s. 2½d. for low carbon 75% to 85%.

MOLYBDENITE remains officially 105s. per unit for 85% MoS_2 for Empire material, which suffices our needs; ferro-molybdenum 15s. per lb. for 70–80%.

SILVER.—The price here continues at $48\frac{7}{16}$d. per oz. for bars, with the American quotation at \$1·01½.

COBALT METAL.—12s. 6d. to 13s. per lb.

COBALT OXIDE.—7s to 7s. 9d. per lb.

CORUNDUM.—90%, £22 to £24 per ton c.i.f.

GRAPHITE.—80%, £50 per ton c i.f.

IRON AND STEEL.—These markets have, of course, been very much under control during the war period. However, during the past month some signs of emancipation have been seen. The position in regard to these metals has been considerably more complicated than in the case of others, the subsidies ruling during the war making a return to old conditions more difficult. Amended prices for home and export have been compiled. Subsidies on steel will be withdrawn at the end of January, and those on pig iron at the end of April. Meantime, steel-works are busy on shipbuilding and constructional material, while good inquiry has been in evidence for rails. In pig iron a good demand is experienced from the home trade, as well as for export. Certain shipments have been permitted for the Allies, but owing to inadequacy of the output those to neutrals cannot be allowed at present.

PRICES OF CHEMICALS. January 6

		£	s.	d
Alum	per ton	20	10	0
Alumina, Sulphate of	,,	20	0	0
Ammonia, Anhydrous	per lb.		1	10
,, 0·880 solution	per ton	34	0	0
,, Carbonate	per lb.			6
,, Chloride of, grey	per ton	50	0	0
,, ,, ,, pure	per cwt.	4	0	0
,, Nitrate of	per ton	80	0	0
,, Phosphate of	,,	125	0	0
,, Sulphate of	,,	17	10	0
Antimony Sulphide	per lb.		1	4
Arsenic, White	per ton	90	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	47	10	0
Bleaching Powder, 35% Cl.	,,	15	0	0
Borax	,,	42	0	0
Copper, Sulphate of	,,	60	0	0
Cyanide of Sodium, 100%	per lb			10
Hydrofluoric Acid	,,			7
Iodine	,,		14	0
Iron, Sulphate of	per ton	9	0	0
Lead, Acetate of, white	,,	165	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	54	0	0
,, White	,,	60	0	0
Lime, Acetate, brown	,,	37	0	0
,, ,, grey 80%	,,	45	0	0
Magnesite, Calcined	,,	35	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate	,,	14	0	0
Methylated Spirit 64° Industrial	per gal		8	7
Phosphoric Acid	per lb		1	8
Phosphorus, yellow	,,		1	10
Potassium Bichromate	,,		2	3
,, Carbonate	per ton	150	0	0
,, Chlorate	per lb.		2	0
,, Chloride 80%	per ton	55	0	0
,, Hydrate, (Caustic) 90%	,,	400	0	0
,, Nitrate	,,	66	0	0
,, Permanganate	per lb		12	0
,, Prussiate, Yellow	,,		2	10
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	7
,, Acetate	per ton	140	0	0
,, Arsenate 45%	,,	70	0	0
,, Bicarbonate	,,	8	10	0
,, Bichromate	per lb.		1	2
,, Carbonate (Soda Ash)	per ton	10	0	0
,, ,, (Crystals)	,,	4	5	0
,, Chlorate	per lb.		1	0
,, Hydrate, 76%	per ton	26	10	0
,, Hyposulphite	,,	28	0	0
,, Nitrate, 95%	,,	26	0	0
,, Phosphate	,,	60	0	0
,, Prussiate	per lb.		1	0
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)	,,	3	0	0
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	33	0	0
Sulphur, Roll	,,	22	0	0
,, Flowers	,,	28	10	0
Sulphuric Acid, Non-Arsenical 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		3	9
Zinc Chloride	per ton	24	10	0
Zinc Sulphate	,,	24	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Else-where	Total	Value
	Oz.	Oz.	Oz.	£
Year 191[illegible]	8,753,563	370,731	9,124,299	38,757,560
Year 191[illegible]	[illegible]	363,826	8,794,824	37,358,040
Year 191[illegible]	8,033,567	[illegible]	8,378,139	35,588,075
Year 1915	8 772,919	320,752	9,073,671	38,627,461
Year 1916	8,971,359	324,179	[illegible]	39,484,934
Year 1917	[illegible]	307,527	[illegible]	38,323 921
January, 1918	[illegible]	19 991	[illegible]	3,033,653
February	637,571	22,188	659,759	2,802,477
March	[illegible]	19,273	696,281	2,957,614
April	697,733	19,366	717,099	3,046,045
May	720,539	[illegible]	741,317	3,148,915
June	708,908	18,788	727,696	3,091 058
July	[illegible]	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	[illegible]	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	[illegible]	17,[illegible]	655,701	2,797,983

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
October 31, 1917	170,531	11,841	4,620	186,792
November 30	169,083	11,633	4,620	185,336
December 31	172,740	11,[illegible]	4,593	18[illegible],028
January 31, 1918	176,424	11,469	4,715	192,608
February 28	181,066	11,243	4,825	197,134
March 31	183,055	11,076	[illegible]	198,876
April 30	[illegible]	11,322	4,753	198,567
May 31	179,879	11,[illegible]	4,773	195,863
June 30	179,028	11,473	4,747	[illegible]
July 31	178,412	11,790	5,011	195,213
August 31	179,390	11,[illegible]	4,954	196,294
September 30	179,399	12,[illegible]08	4,889	196,395
October 31	173 153	11,[illegible]	4,749	189,726
November 30	160,275	11,826	4,016	176,117

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 80% of the working profit.

	Tons milled	Yield per ton	Working cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
April, 1917	2,235,833	[illegible]	19 [illegible]	7 8	857,710
May	2,405,855	[illegible] 4	18 [illegible]	7 5	[illegible]
June	2,285,426	26 11	19 2	7 7	867,639
July	2,294,668	26 11	19 0	7 7	[illegible]
August	2,301,892	26 9	19 0	7 6	859 517
September	2,195,884	27 5	19 4	7 9	848,096
October	2,280,461	26 10	19 5	7 2	[illegible]
November	2,156,814	[illegible] 4	19 11	7 [illegible]	775,502
December	2,130,510	[illegible]	20 0	7 4	783,729
January, 1918	2,167,411	27 1	20 7	6 4	703,665
February	1,946,338	[illegible]	21 7	5 11	577,396
March	2,107,561	27 1	21 4	5 8	596,109
April	[illegible]	27 0	20 8	6 2	[illegible]
May	2,237,644	[illegible]	20 6	6 5	[illegible]
June	2,124,205	28 2	21 0	6 11	[illegible]
July	[illegible]	27 10	21 2	6 6	702,360
August	2,158,431	28 1	21 7	6 [illegible]	676,146
September	2,060,635	[illegible]	22 0	5 10	600,330

Production of Gold in Rhodesia and West Africa

	Rhodesia.		West Africa.	
	1917	1918	1917	1918
	£	£	£	£
January	296,113	[illegible]	131,665	[illegible]
February	289,734	232,023	104,892	112,865
March	300,183	[illegible]	[illegible]	[illegible]
April	297,977	239,916	123,825	[illegible]
May	299,271	239,205	121,104	[illegible]
June	302,195	[illegible]	[illegible]	[illegible]
July	288,731	251,740	142,017	[illegible]
August	294,359	[illegible]	[illegible]	120,526
September	[illegible]	[illegible]	[illegible]	115,152
October	289,978	136,780	126,295	61,461
November	275,829	145,460	126,915	108,796
December	270,616	—	[illegible]	—
Total	3 495,391	[illegible]	1,529,977	1,220,932

West Australian Gold Statistics.

	Reported for Export oz	Delivered to Mint oz	Total oz	Total value £
January, 1918	*	73,703	*	*
February	*	76,987	*	*
March	*	69 730	*	*
April	*	[illegible]	*	*
May	*	73,701	*	*
June	*	74,904	*	*
July	*	72,051	*	*
August	*	76,156	*	*
September	*	74,057	*	*
October	*	71,439	*	*
November	1,444	70,711	72 155	306,494
December	[illegible]	[illegible]	[illegible]	[illegible]

* By direction of the Federal Government the export figures from July, 1916, to November, 1918, were not published.

Australian Gold Returns

	Victoria.		Queensland.		New South Wales	
	1917	1918	1917	1918	1917	1918
	£	£	£	£	£	£
January	67,627	32,134	50,150	47,600	29,000	25,000
February	65,450	58,113	63,200	45,470	26,000	28,000
March	[illegible]	65,412	61,200	48,020	41,000	30 000
April	75,139	26,849	62,470	[illegible]	21,000	[illegible]
May	65,623	[illegible]	[illegible]	[illegible]	[illegible]	45,000
June	[illegible]	45,765	73,100	[illegible]	24,000	32,000
July	68,937	64,347	71,820	[illegible]	44,000	25,000
August	101,428	61,163	74,800	44,600	21,000	21,000
September	61,701	—	64,180	[illegible]	20,000	[illegible]
October	33,533	—	54,400	54,400	47,000	[illegible]
November	75,912	—	42,380	38,200	29,000	25,000
December	56,967	—	64,170		19,000	—
Total	846,540	443,102	744,537	500,950	349,000	334,000

Production of Gold in India.

	1915	1916	1917	1918
	£	£	£	£
January	201,255	192,150	190,047	176,030
February	195,970	183,264	180,904	173,343
March	194,350	186,475	189,618	177,950
April	196,747	192,208	185 835	176,486
May	199,786	193,604	[illegible]	[illegible]
June	197,447	192,469	[illegible]	[illegible]
July	197,056	191,404	[illegible]	171,950
August	197,984	192,784	181,005	172 105
September	195,952	192,330	183,630	170,360
October	195,531	191,502	182,924	167,740
November	192,714	192,298	182,388	157,176
December	204,590	205,164	[illegible]	
Total	2,369,382	2,305,652	2,214,163	1,891,290

Imports of Ores and Metals into United Kingdom

Long tons

	Nov. 1918	Dec. 1918	Year 1918
	Tons	Tons	Tons
Iron Ore	498,529	465,866	[illegible]
Copper Ore	[illegible]	1,332	[illegible]
" Precipitate	2,107	[illegible]	21,031
" Metal	25,809	12,206	[illegible]
Copper and Iron Pyrite	45,497	[illegible]	836,703
Tin Concentrate	1,532	3,550	[illegible]
" Metal	1,735	797	12,567
Manganese Ore	47 335	21,398	[illegible]
Lead, Pig and Sheet	[illegible]	14,851	[illegible]
Zinc (spelter)	4,901	[illegible]	[illegible]
	lb.	lb.	lb.
Quicksilver	—	—	[illegible]

EXPORTS OF COPPER FROM UNITED STATES

1917	Long tons	1918	Long tons	1918	Long tons
July ...	38,127	January	40,530	July	28,826
August .	45,304	February ...	28,160	August ...	[illegible],440
September ...	30,493	March	22,550	September..	32,730
October ...	39,115	April	22,227	October......	-
November ...	38,638	May	28,889	November..	—
December ..	35,000	June	31,791	December..	—
Total 1917 ...	484,120	Total	182,786	Total 1918...	264,780

OUTPUTS OF TIN MINING COMPANIES.

In Tons of Concentrate.

	Oct. 1918 Tons	Nov. 1918 Tons	Year 1918 Tons
Nigeria			
Abu	2	2	33
Anglo-Continental	15	12	191
Benue	6	6	139
Bisichi	21	19	255
Bongwelli	3	–	15
Dua	4	4	50
Ex-Lands	24	–	294
Filani	2	3	34
Forum River	15	15	259
Gold Coast Consolidated	8		30
Gurum River	5	6	87
Jantar	8	–	115
Jos	21	17	210
Kaduna	6	27	149
Kano	7	10	46
Kassa-Ropp	9	–	113
Keffi	7	4	112
Kuskie	1	1	20
Kwall	6	5	103
Lower Bisichi	11	9	90
Lucky Chance	2	2	25
Minna	3	1	40
Mongu	40	31	441
Naraguta	38	34	447
Naraguta Extended	16	23	253
New Lafon	20	20	178
Nigerian Tin	9	8	79
N. N. Bauchi	30	25	415
Ofin River		–	87
Rayfield	40	44	634
Ropp	67	68	770
Rukuba	7	8	123
South Bukeru	4	2	91
Sybu	3	2	37
Tin Areas	5	8	88
Tin Fields	13	–	96
Toro	2	1	15
Federated Malay States:			
Chenderiang	–	–	134
Gopeng	65	87	893
Idris Hydraulic	9	12	122
Ipoh	13	13	229
Kamunting	–	–	165
Kinta	30	36	436
Kledang	–		18
Lahat	30	24	381
Malayan Tin	53	59	680
Pahang	154	152	1,7[illegible]4
Rambutan	12	21	191
Sungei Besi	42	42	366
Tekka	30	30	461
Tekka-Taiping	44	33	379
Tronoh	99	131	1,232
Tronoh South	5	5	131
Cornwall:			
Cornwall Tailings	11	–	140
Dolcoath	56	56	725
East Pool	105	142	1,194
Geevor	37	29	369
South Crofty	40	40	560
Other Countries:			
Aramayo Francke (Bolivia)	176	176	1,631
Briseis (Tasmania)	27	25	3[illegible]7
Deebook (Siam)	3[illegible]	30	359
Mawchi (Burma)	4[illegible]	34	605
Porco (Bolivia)	[illegible]	26	205
Renong (Siam)	36	44	565
Rooiberg Minerals (Transvaal)	35	25	305
Siamese Tin (Siam)	58	56	918
Tongkah Harbour (Siam)	85	88	1,171
Zaaiplaats (Transvaal)	25	42	518

NIGERIAN TIN PRODUCTION

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1913 Tons	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons
January	[illegible]	485	417	53[illegible]	[illegible]	678
February	427	469	358	528	646	668
March	510	502	418	547	655	707
April	430	482	444	[illegible]	555	5[illegible]4
May	360	480	357	536	509	525
June	321	460	373	510	47[illegible]	492
July	357	432	455	506	479	545
August	406	228	438	498	551	571
September	422	289	442	535	[illegible]	506
October	480	272	511	5[illegible]4	[illegible]	484
November	445	[illegible]	467	674	621	418
December	478	326	533	654	655	—
Total	5,103	4,708	5,213	6,594	6,927	6,17[illegible]

TOTAL SALES OF TIN CONCENTRATE AT REDRUTH TICKETINGS

	Long tons	Value	Average
Total, 1917	4,1[illegible]	[illegible]	£134 0 0
January 14, 1918	141	£23,563	£167 2 3
January 28	171½	£[illegible]	£168 19 2
February 11	166⅝	£29,674	£1[illegible] 4 6
February 25	15[illegible]	£28,213	£180 18 4
March 11	178¼	£33,398	£187 7 4
March 25	169[illegible]	£31,253	£184 7 9
April 8	157¼	£[illegible]	£188 1 8
April 22	159½	£31,[illegible]	£196 17 7
May 6	172[illegible]	£39,999	£232 4 4
May 21	169½	£36,791	£217 1 2
June 3	172	£36,109	£[illegible]09 18 9
June 18	153	£29,692	£1[illegible]4 1 9
July 1	170[illegible]	£34,035	£[illegible] 12 [illegible]
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£[illegible] 4 6
August 12	144	£33,116	£2[illegible]9 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£[illegible]	£[illegible] 1 [illegible]
September 24	145¾	£29,639	£[illegible] 7 [illegible]
October 7	136½	£27,037	£197 14 [illegible]
October 21	150	£29,672	£197 16 4
November 4	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	16[illegible]	£[illegible]	£150 19 0
December 16	175½	£26,032	£[illegible] 6 [illegible]
December 30	152	£19,539	£128 11 1
Total and Average 1918	4,094	£786,541	£192 0 0

DETAILS OF REDRUTH TIN TICKETINGS.

	Tons Sold December 6.		Tons Sold December 30.	
	Tons Sold	Realized per ton £ s d	Tons Sold	Realized per ton £ s. d
E. Pool & Agar, No. 1	17	154 5 0	15	139 0 0
„ „ No. 1a	17	151 0 0	15	134 0 0
„ „ No. 1b	18	148 12 6	15	130 0 0
„ „ No. 1c	18	147 12 6	15	130 0 0
Dolcoath, No. 1	9	149 10 0	8	134 0 0
„ No. 1a	9	150 7 6	8	132 7 6
„ No. 1b	9	150 7 6	9	133 10 0
„ No. 2	2½	81 15 0	[illegible]	75 0 0
„	1½	145 7 6	2½	120 0 0
South Crofty, No. 1	10	144 0 0	9	130 0 0
„ „ No. 1a	10	145 7 6	9	1[illegible] 5 0
Grenville Utd., No. 1	7	145 0 0	6	12[illegible]
„ „ No. 1a	8	145 12 6	7	129 5 0
„ „ No. 2	-		3	50 0 0
Tincroft Mines, No. 1	7	156 15 0	6	1[illegible]
„ „ No. 1a	7	154 15 0	6	1[illegible]
Levant Mines	12	15[illegible] 0 0		
Basset Mines	10½	149 10 0	9	[illegible]
Hemerdon Mines	2	145 0 0		
Trencrom Hill	1	127 12 6		
Botallack B.	–		[illegible]	1[illegible] 0 0
Wheal Bellan	—		1[illegible]	1[illegible] 6
Pendeen Mines	-	-	1[illegible]	112 10 0
Total	175½		152	

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Jan. 5, 1918 £ s. d.	Jan. 6, 1919 £ s. d.
RAND:		
Bantjes	3 0	5 6
Brakpan	5 11 3	3 15 0
Central Mining (£8)	6 5 0	7 11 3
Cinderella	3 9	6 0
City & Suburban (£4)	1 3 9	15 0
City Deep	3 8 0	2 13 0
Consolidated Gold Fields	1 10 6	1 14 6
Consolidated Langlaagte	1 1 0	1 0 0
Consolidated Main Reef	15 6	15 6
Consolidated Mines Selection (10s)	1 8 9	1 7 3
Crown Mines (10s.)	2 1 3	2 2 6
Daggafontein	1 9 6	1 8 0
D. Roodepoort Deep	10 6	10 0
East Rand Proprietary	5 6	5 0
Ferreira Deep	13 9	13 9
Geduld	1 18 6	1 17 6
Geldenhuis Deep	17 6	13 0
Gov't Gold Mining Areas	3 16 3	4 13 0
Heriot	1 16 3	1 0 0
Jupiter	5 0	5 0
Kleinfontein	1 1 9	14 3
Knight Central	3 3	5 6
Knight's Deep	10 0	8 0
Langlaagte Estate	15 3	1 0 0
Meyer & Charlton	5 12 6	5 0 0
Modderfontein (£4)	23 5 0	26 17 6
Modderfontein B	8 12 6	7 17 6
Modder Deep	7 12 6	7 15 0
Nourse	1 0 0	16 3
Rand Mines (5s.)	3 1 3	3 0 0
Rand Selection Corporation	4 12 6	4 7 6
Randfontein Central	11 3	12 9
Robinson (£5)	18 9	16 0
Robinson Deep A (1s.)	1 3 9	1 0 0
Rose Deep	1 2 6	18 9
Simmer & Jack	5 6	4 9
Simmer Deep	2 9	3 0
Springs	3 13 0	3 15 9
Sub Nigel	1 9 6	1 13 9
Van Ryn	1 5 6	17 6
Van Ryn Deep	3 13 9	3 12 6
Village Deep	1 2 0	17 6
Village Main Reef	15 0	14 6
Witwatersrand (Knight's)	1 17 0	1 5 0
Witwatersrand Deep	7 0	14 0
Wolhuter	7 6	5 0
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	1 0 0	1 2 6
Sheba (5s.)	1 3	1 3
Transvaal Gold Mining Estates	18 3	15 0
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	13 15 0	16 5 0
Jagersfontein	4 7 6	4 5 0
Premier Deferred (2s. 6d.)	7 0 0	6 15 0
RHODESIA:		
Cam & Motor	10 9	8 0
Chartered British South Africa	15 0	1 3 3
Eldorado	7 6	7 0
Falcon	19 6	1 0 0
Gaika	6 6	17 9
Giant	9 3	8 0
Globe & Phœnix (5s.)	1 11 3	1 8 0
Lonely Reef	1 13 6	1 18 9
Rezende	4 17 6	4 13 9
Shamva	1 12 6	1 15 0
Wanderer (3s.)	2 0	1 0
Willoughby's (10s.)	5 3	6 9
WEST AFRICA:		
Abbontiakoon (10s.)	4 0	5 0
Abosso	7 6	7 6
Ashanti (4s.)	1 1 0	1 0 0
Prestea Block A	4 3	4 0
Taquah	16 6	14 6
WEST AUSTRALIA:		
Associated Gold Mines	2 0	3 3
Associated Northern Blocks	2 6	4 0
Bullfinch	2 0	1 9
Golden Horse-Shoe (£5)	2 5 0	1 15 0
Great Boulder Proprietary (2s.)	13 0	11 3
Great Fingall (10s.)	1 3	2 0
Ivanhoe (£5)	2 4 6	1 13 9
Kalgurli	11 0	12 0
Sons of Gwalia	12 6	9 9

GOLD, SILVER, cont.	Jan. 5, 1918 £ s. d.	Jan. 6, 1919 £ s. d.
OTHERS IN AUSTRALASIA:		
Mount Boppy, New South Wales	6 0	5 0
Talisman, New Zealand	15 0	12 0
Waihi, New Zealand	1 17 3	2 1 6
Waihi Grand Junction, New Z'land	17 0	15 0
AMERICA:		
Alaska Treadwell (£5), Alaska	—	2 0 0
Buena Tierra, Mexico	10 0	1 2 6
Camp Bird, Colorado	7 6	17 0
Casey Cobalt, Ontario	6 3	2 6
El Oro, Mexico	7 9	16 0
Esperanza, Mexico	7 6	8 6
Frontino & Bolivia, Colombia	12 6	12 6
Le Roi No. 2 (£5), British Columbia	6 3	9 0
Mexico Mines of El Oro, Mexico	5 12 6	5 18 9
Oroville Dredging, California	18 3	1 0 6
Plymouth Consolidated, California	1 2 6	1 3 6
St. John del Rey, Brazil	17 9	17 6
Santa Gertrudis, Mexico	14 0	14 6
Tomboy, Colorado	1 1 0	14 0
RUSSIA:		
Lena Goldfields	1 10 0	1 15 0
Orsk Priority	12 6	15 0
INDIA:		
Balaghat	3 3	5 6
Champion Reef (2s. 6d.)	5 6	5 3
Mysore (10s.)	3 0 0	2 7 6
North Anantapur	5 0	2 6
Nundydroog (10s.)	1 4 6	1 1 0
Ooregum (10s.)	18 6	18 0
COPPER:		
Arizona Copper (5s.), Arizona	2 7 0	2 3 9
Cape Copper (£2), Cape Province	2 17 6	2 15 0
Chillagoe (10s.), Queensland	9	1 6
Cordoba (5s.), Spain	3 0	3 0
Great Cobar (£5), N.S.W	1 6	4 6
Hampden Cloncurry, Queensland	1 11 6	1 5 0
Kyshtim, Russia	1 10 0	1 16 3
Messina (5s.), Transvaal	8 6	5 0
Mount Elliott (£5), Queensland	3 10 0	3 10 0
Mount Lyell, Tasmania	1 5 9	1 5 0
Mount Morgan, Queensland	1 13 6	1 9 6
Namaqua (£2), Cape Province	2 15 0	2 2 6
Rio Tinto (£5), Spain	64 0 0	64 0 0
Sissert, Russia	1 0 0	1 1 3
Spassky, Russia	1 5 0	2 0 0
Tanalyk, Russia	1 10 0	2 10 0
Tanganyika, Congo and Rhodesia	3 10 0	5 2 6
Tharsis (£2), Spain	5 10 0	5 15 0
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 11 9	1 7 3
British Broken Hill	1 15 6	2 15 0
Broken Hill Proprietary (8s.)	2 12 9	3 0 3
Broken Hill Block 10 (£10)	1 4 0	1 12 6
Broken Hill North	2 14 9	3 0 6
Broken Hill South	9 7 6	3 0 6*
Sulphide Corporation (15s.)	1 8 3	1 8 0
Zinc Corporation (10s.)	19 3	1 7 3
ASIA:		
Burma Corporation	4 0 6	4 10 0
Irtysh Corporation	1 10 6	1 17 6
Russian Mining	12 6	1 0 0
Russo Asiatic	3 3 9	4 5 0
TIN:		
Aramayo Francke, Bolivia	1 14 6	3 3 9
Bisichi, Nigeria	14 6	14 0
Briseis, Tasmania	5 0	5 0
Dolcoath, Cornwall	11 9	8 3
East Pool, Cornwall	16 9	1 7 0
Ex-Lands Nigeria (2s.), Nigeria	2 0	2 9
Geevor (10s.) Cornwall	17 9	1 0 0
Gopeng, Malay	1 13 9	2 0 0
Ipoh Dredging, Malay	16 0	18 9
Malayan Tin Dredging, Malay	2 3 9	2 5 0
Mongu (10s.), Nigeria	14 6	14 9
Naraguta, Nigeria	17 0	18 0
N. N. Bauchi Pref. (10s.), Nigeria	11 9	12 6
" Ord. (10s.)	5 6	7 3
Pahang Consolidated (5s.), Malay	11 6	14 0
Rayfield, Nigeria	12 3	12 6
Renong Dredging, Siam	2 19 0	2 1 3
Ropp (4s.), Nigeria	17 0	1 1 0
Siamese Tin, Siam	2 17 6	3 10 0
South Crofty (5s.), Cornwall	1 1 6	2 0 0
Tekka, Malay	3 12 6	4 0 0
Tekka Taiping, Malay	3 15 0	3 17 6
Tronoh, Malay	1 10 0	1 17 6

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

BROKEN HILL PROPRIETARY'S IRON & STEEL WORKS.

The yearly meeting of the Australian Institute of Mining Engineers was held recently at Newcastle, New South Wales, and the members were afforded the opportunity of viewing the Broken Hill Proprietary's iron and steel works. As details of this great industry are not generally known in this country, we quote a description of the works, circulated at the time, printed in *Chemical Engineering and Mining Review*, of Melbourne, for August last. Owing to shipping restrictions and delays, this account has only just arrived in this country. The description deals with the position at the time, before the decision was made to double the blast-furnace capacity and to increase the steel furnaces and the rolling mills. Brief notice of these expansions were given in our issue of September last.

Five years ago the Broken Hill Proprietary acquired an area of low-lying swampy land at Port Waratah, near the city of Newcastle, for the purpose of establishing steel works. The works are so situated that they are advantageously placed for the unloading and loading of ore and other material, and for the despatch of the finished products of the works. Standing out boldly at what is almost a point formed by a sweep of the river Hunter, the blast-furnaces and stoves, the ore conveyors, the blooming and rolling mills, and the large bank of coke ovens to the west are clearly visible from any part of the city and suburbs and to everyone entering the harbour. The first instalment of plant, which came from America, arrived in Newcastle on January 3, 1914. In the meantime the channel leading up to the works was deepened by the Government so as to take vessels up to 25 ft. draught, and the sand from the dredging served to fill in the low-lying ground. Then the contractors were able to get to work with the foundations for the blast-furnace and stoves, while at the same time work was commenced upon the coal bin, from which the coal mined locally can be loaded into vessels for shipment to Port Pirie and Broken Hill. The putting in of the foundations for the furnace and stoves was by no means a light work. A large number of piles had to be driven to secure a stable bottom for the concrete beds, which are built up to a height of about 12 ft. from the level of the ground. The furnaces and stoves stand at a short distance from the water, and a vessel drawing alongside the 1,300 ft. of wharfage opposite them can be unloaded and the ore carried direct to the blast-furnace, receiving bins, or to the stock pile. This is done by means of two mechanically-operated ore bridges, running high above the wharves. The ore is taken from the ship's hold with grab buckets, and by this means a ship can be quickly unloaded, and the ore-bins kept full all the time.

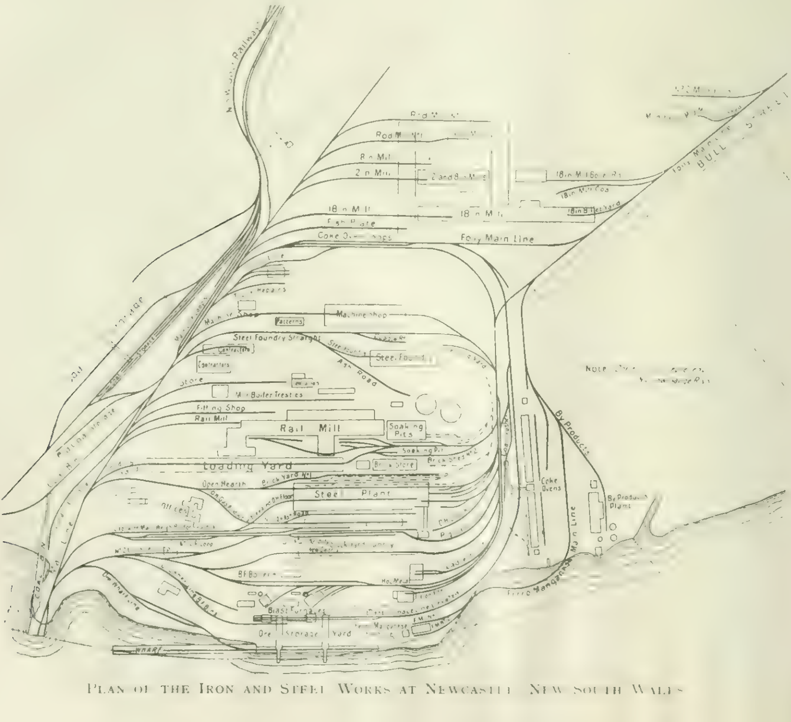
The blast-furnace, which has a capacity of 500 tons of pig iron per day, is of the quick-running Pittsburgh type, and it differs from the ordinary water-jacket type of blast-furnace, in that a stream of water is constantly running down the exterior, thus serving the double purpose of keeping the lower part of the furnace, near the tuyeres, at a moderate temperature externally, and so preserving the inner walls from erosion as the great mass of material presses down within, and preventing the radiation of heat. The charging of the furnace is effected by means of a Baker-Newman rotary distributor. The furnace is 90 ft. high. The waste gas from the top of the furnace is taken through a dry dust-catcher, and thence through a Steece and Ford washer which removes 95% of the total amount of suspended matter from the gas. The washed gas is then distributed through mains to four hot-blast stoves of the improved Cowper type. These stoves are each 21 ft. in diameter, being each almost as large as the furnace, and they rise 90 ft. from the concrete beds upon which they are placed. In the stoves the blast for the furnace is heated to an average temperature of 1,300 deg. F. The blowing engines are three in number, two high-pressure and one low-pressure, two being required at one time to operate the furnace. 35,000 cubic feet of air per minute, required to keep the furnace running, is forced by the blowing engines through one of the stoves into the blast-furnace.

The tapping of the blast-furnace is carried out every four hours. The quantity of metal run off at each tapping varies from 60 to 80 tons. When the furnace is tapped the metal flows away by gravitation, and is turned, by means of one of the many baffles in use, toward the 45 ton ladles. A second blast-furnace, with a capacity of 500 tons pig iron per day, is now being constructed, and will shortly be completed. A smaller furnace of 100 tons per day capacity is in commission, producing pig iron for the use of ironfounders. Included in this department is a direct metal foundry where heavy castings, principally ingot moulds, are turned out.

From the blast-furnace the ladles containing the pig are run across to the open-hearth steel department close by. This department at present consists of seven 65 ton basic open-hearth furnaces of the stationary type. As the works expand the number of steel furnaces will be increased, and there is room on the property for 14, if found necessary to build. Probably this will be done, because the system found most advantageous in America, when several blast-furnaces are running, is to have a nest of 14 steel furnaces. A single charge of one of the steel furnaces consists of 40,000 lb. of steel scrap, 80,000 lb. of pig iron, 20,000 lb. of limestone, and 12,000 lb. of ore. The containers holding the charges are placed on trucks and pushed up an inclined railway by a locomotive from the ground level to the charging floor. The process adopted in connection with the making of steel is the direct-metal process. Under this system the molten metal is conveyed from the blast-furnace to a steel mixer with a capacity of 1,000 tons, from whence it is taken into the furnace without being allowed to cool, thus ensuring a continuous supply of hot metal of even analysis for the open hearths. From the mixer the molten metal is poured into a 40 ton ladle and conveyed to the furnace by the overhead crane. The mixer when full has a total weight of from 1,200 to 1,300 tons and is operated by a boy manipulating a lever. The steel produced in the furnace is tapped from the back, and is run off into 75 ton ladles. As it pours out, a certain proportion of ferro-manganese and ferro-silicon is thrown into the ladle, and this mixes with the steel, for the purposes of hardening and deoxidizing the metal. The steel having been run off from the furnace, the ladle is lifted by means of a 100 ton travelling crane, and the metal is poured into 3 ton ingot moulds.

When the ingot moulds are filled and the metal has cooled down somewhat they are switched, with the trucks, into the soaking pit at the northern end of the building—about 300 yards long—which houses the blooming and rolling mills. Here an electrically-driven stripping machine of 150 tons capacity removes the mould from the ingot, and a stiff-leg charging crane lifts and places the red hot ingots in the soaking pits. Each of the latter has four holes, each hole taking six ingots. The object of placing the ingots in the soaking pits is to bring them to a uniform temperature throughout; otherwise they would be too cold on the outside and too hot within for the purposes of blooming and rolling. When they have been brought to the desired temperature the ingots are removed by the crane, and are placed on the approach table to the blooming mill. This mill and the engine for driving it were built by MacIntosh, Hemphill and Co., of Pittsburgh. It is a 35 in. geared mill, of massive construction, and it is driven by a twin reversing engine of high power, with cylinders 42 by 60 in. When the ingot goes on to the approach table it is about 20 in square and about 5 ft. long. In 15 passes the ingot is reduced to a bloom four or six inches square. Passing along to the shearing machine, the bloom is cropped at both ends, and then cut into billets of any length that may be required, so as to be ready for the rolling mill. The first billets are run into the 28 in. rail mill on electrically driven travelling tables. The other billets are carried mechanically to a re-heating furnace, close to the shearing machine, where they are kept at the right temperature until their turn comes to pass on to the rail mills. The billet is converted into the completed rail in nine passes, the operation taking only about 90 seconds. This mill, which was made at the works of the United Engineering and Foundry Company, of Pittsburgh, is fed by two large travelling tables, and is driven by a twin horizontal engine, with cylinders 42 by 60 in. The engine is of the reversible type, and has no flywheel. The mill is of the type known as a three-high mill, which is the type of rolling mill most favoured by United States steel-rail makers. The engine is operated only in one direction, except in the case of trouble arising with the piece which is being rolled, when the engine can be immediately reversed and the piece withdrawn from the rolls.

After leaving the rail mill the rail is carried under a



PLAN OF THE IRON AND STEEL WORKS AT NEWCASTLE, NEW SOUTH WALES.

circular saw of the sliding type, which cuts it into the required lengths. The rail is then taken to the hot-beds, where it is allowed to cool. Afterward it is removed from the hot-bed and delivered to the finishing mill, where it is straightened, ended if necessary, and drilled ready for use. Special soaking pits and beds are provided for treating small billets, and for rolling and handling plates special gear is available. These two mills, blooming mill and rail mill, are of sufficient capacity and power to deal with an output up to 1,000 tons of finished rails per day. The plant in the finishing mill department is, in its turn, sufficient to handle the entire output of the open-hearth, and to make of it the completed rails. The article also describes briefly the merchant mills, rod mills, iron and steel foundry, and the preparations for structural steel production.

A large quantity of coke is required for the blast-furnace department, and this is made on the spot. Coal for the ovens is delivered to the crushing and screening plant, which is equipped with mechanical handling appliances. The ovens are the Semet-Solvay recuperative by-product type. The output at the time of writing amounts to 450 tons of coke per day. The recovery of sulphate of ammonia per ton of coal is 22 lb., of tar 7½ gallons, and of gas 12,800 cu. ft., of which about 5,000 is available for power purposes after furnace requirements are met. The original plant consisted of 66 ovens, but has been increased to 99; construction work on an additional 33 is now in hand. The stack for the ovens is built of steel; it is 160 ft. high, and has not a single stay. A second stack of similar construction is in course of erection. The gas from the ovens is passed through condensers, then taken to the by-product house, where tar and ammonia are extracted. The two saturators where the ammonia content is separated have a capacity of about eight million cu. ft. of gas per day each. There are two saturators in operation, and a third is being installed. The ammonia is subsequently used in the manufacture of sulphate of ammonia for agricultural purposes. A portion of the gas obtained from the coke is used for heating the ovens in the production of more coke, while the remaining portion is used in the works for heating furnaces and various other purposes. The tar is also being used as a fuel in some of the furnaces.

A new inclined bench has been tried, and has proved successful. This provides for the coke after discharge from the oven through a Darby quencher, falling down the inclined bench direct into trucks, the breeze falling through slots on to a belt and then into a bin. From the trucks the coke is tipped directly to the skip car at the blast-furnace, and the ore and limestone are collected by means of a travelling hopper, electrically operated, which weighs the charge as it comes from the blast-furnace stock-bins and conveys it to the skip-car. This single skip-car then runs up an incline to the point where the charge is dumped into the blast-furnace.

JAPANESE PETROLEUM RESOURCES AND PRODUCTION.

In *Economic Geology* for November, J. Morgan Clements gives an account of the petroleum industry of Japan.

For a number of years petroleum has ranked among the highest, being third in value, of the mineral products of Japan. The petroleum industry is really one of the relatively old industries of the country, although it is only since 1891 that it has been put upon a modern basis. A picture is extant showing the presentation in 668 to the Emperor Tenchi (Tenji) of "burning water" and "burning earth," by his subjects from Echigo Province. The "moryuru-mizu," burning water, was doubtless oil, and the burning earth was probably bituminous shale, or other oil soaked rocks coming from near the seepages of oil. The early methods of getting the oil were very simple. Where the seepages occurred, as at Kurokawe in the Niitsu field in Echigo, a trench along the seepage or shallow wells were dug and allowed to fill with oil, which was then bailed out. In some cases they filled with oil and water and overflowed. It has been stated that about 1818 the oil men began to sink deeper wells dug by hand. Some of these deeper wells must have been dug, it would seem, long before this time, for the oil was utilized to a limited extent in Echigo, where it was first discovered, during the 300 odd years preceding the Moiji Era, of 1868. Its potential value was not recognized until kerosene began to be imported and used in Japan. Then when the Japanese learned early in the Meiji Era that kerosene was derived from the natural oil with which they were acquainted, they began to develop their natural resources by digging deeper wells by hand to obtain more oil, and also by refining the oil by crude methods to produce illuminating oils. In the refining they were guided by information obtained from the books available to them Later on still deeper wells were dug by hand to reach the oil sands. The deepest one of these, of which the author could learn, reached a depth of 894 ft. In 1876 Benjamin Smith Lyman, an American who had been studying the mineral resources of Hokkaido for the Japanese Government, was sent into the Echigo oil district and prepared geological maps of the oilfields. Based on these, the Japanese oil producers began more enlightened development of the fields, but still keeping to the hand-dug wells. Toward the end of the eighties an American well-drilling outfit was secured, but the repeated efforts to drill a well to the oil sands failed, as the result of the lack of experience of the Japanese operators of the drill. The Nippon Petroleum Company, incorporated in 1888, with Hishahiro Naito the president then, as he is now, secured a complete well-drilling outfit and competent drill men through the Japanese Consul in New York, and in the autumn of 1890 the drill was set up over an old dug well. Drilling was started in December of the same year, and a well 1,000 ft. deep was completed in April, 1892, and began with a production of 45 barrels per day of oil of 42° Baumé. Other productive wells were drilled in succession to a depth of 1,500 ft. This successful use of American drilling outfits led to the rapid adoption of them by the progressive Japanese. Drill outfits and drillers to operate them were brought to the Japanese oilfields. Going even farther than this, as the industry developed, the Nigata Iron Works, owned then by one of the large oil companies, sent its superintendent, Mr. Sasamura, to the United States to study the manufacturing end of oil drilling and refining machinery and supplies. On his return a company entered upon the manufacture of these essentials to the oil industry, and to-day produces a large amount of the necessary oil-drilling machinery and supplies, following closely the American prototypes. At the present time most of the equipment for drilling wells and refining oil is produced in Japan. Casing is, however, still bought in the United States. The derricks used are of the usual American type. It has been the well-established policy of one of the large oil companies to send some one abroad from time to time to study the oil industry in other parts of the world. When it has been decided to introduce any innovation whatever, the new outfit required is purchased and brought to Japan with an experienced foreign man to run it until the Japanese employees have been trained to handle the machines and operate them. In 1912 American rotary drills were introduced with American drillers, and are now widely used and the Japanese operate them. The same is true in refining. An American trained in a Standard Oil Refinery in the United States is now aiding in the operation of at least one important refinery.

The first gusher was struck with American drill tools on the coast at Amaze in the Nishiyama field, Echigo district, in 1891. This naturally gave great impetus to the oil industry. It is interesting to note that while the large oil companies use extensively American rotary and cable tool drills, there are also used, however, alongside them, the Japanese bamboo spring poles and bamboo string rigs, and one may also see alongside the modern wells and modern types of well-drilling machinery, the "Tebori," deep wells dug by hand. The Nippon Oil Company and the Hoden Oil Company, which operate wells, pipe lines, and refineries, practically control the oil industry of Japan, as they buy most of the oil produced by others. The Standard oil interests were for a while represented by the International Oil Company, but they sold out some years ago, in the summer of 1907, to the Nippon Oil Company, and now the Standard Oil Company operates in Japan only as a seller of petroleum products.

There are five oil districts in Japan proper, situated in the provinces of Echigo, Shinano, Akita, Totomi, and Hokkaido, and one in Taiwan, Formosa. In each of these districts there are one or more fields in which oil is found to occur. In addition to the productive fields, there are others which have been tested and have been proved to produce such small quantities that they could not be operated successfully at this time. Some new fields will doubtless be discovered in the future in these oil districts. Echigo, Akita, Totomi, Hokkaido, and Taiwan districts all produce oil to-day. Echigo and Akita are the two large oil producing districts, producing 99% of all the Japanese oil. The oilfields of Taiwan are in process of development at the present time. The Japanese Navy Department holds five fields which have been reserved for it by the Government, but these fields have not yet been thoroughly tested. The Aiko is generally said to be the most promising of these, and will probably be tested first.

The oil in Japan is associated in all cases with the Tertiary deposits, though every Tertiary area of Japan is not found to carry oil. The oilfields are found in the areas of Tertiary sediments distributed along the sea-coast, excepting in Hokkaido, where the oil district of the Ishikari Valley is near the centre of the island. A probable oilfield has been reported also in Saghalien. The Echigo and Akita districts both occur in the extensive area of Tertiary sediments which occur almost continuously along the west coast of Honshu, the main island of Japan, bordering the Japan Sea, extending from Shinano Province on the south to the northern end of the island. These Tertiary oil-bearing areas are broken up into a series of small mountain ridges, the highest rising to an altitude of 2,300 ft., although the general height is much lower. Between the ridges occur broad level fertile plains covered with rice fields and traversed by meandering streams, used largely for irrigation. The ridges normally correspond to the anticline, and have the same strike north-east to south-west, while the valleys occupy the synclines. Broadly speaking the oilfields correspond with these anticlines. It is probable that in the future new oilfields may be developed in some of these broad plains between the ridges, but as there are no structural guides occurring in the plains it may be some time before the oil operators will venture to drill them.

The Tertiary has not been closely subdivided in Japan, but is probably represented by both Miocene and Pliocene deposits. In the Echigo and Akita districts there are three defined oil horizons. The upper one consists of shale, sandstone, and conglomerate, and the middle one of shale, with thin beds of sandstone. The lower horizon is subdivided into two parts, an upper one of sandstone and shale, and a lower one of shale, sandstone, and tuff beds. The most productive oil strata are in the middle and lower horizons. The sandstone and tuff are the chief oil carriers, though some oil is obtained in places from the shale. Volcanic rocks, lavas, tuffs, and dykes are found in the Tertiary with the oil strata, sometimes contemporaneous with and sometimes intrusive in the sediments. Wherever the oil strata are cut by an intrusion the oil is reported to be of low specific gravity, often averaging even less than 10° Baumé. It is noticeable also that the heavy oils occur in the highest horizons as a rule.

The Nishiyama field is the most productive one in the Echigo district and is typical. The axis of the Nishiyama anticline strikes N45°E, and the north-west side of the anticline has dropped down along a fault along the axis. The shallow wells occur on the south-east side of the anticline. Those so far developed range in depth from 1,490 to 1,790 ft. On the north-west side of the anticline occur the deeper wells. The average depth along here is 2,980 ft. The deepest one so far drilled is No. 73, which reached a depth of 4,613 ft. Both cable and rotary drills are used in drilling these wells. The beds are relatively soft. With the cable drills the average progress is 20 to 35 ft. per day. The record is 60 ft. With rotary drills the average advance is from 100 to 125 ft. per day, and the record is 500 ft. A number of flowing wells have been brought in. The largest gusher was brought in on May 25, 1914, in the Kurokawa lease in the Akita district, and flowed 11,350 barrels of 42 gallons per day. The flow rapidly decreased in quantity and after about five months it was necessary to pump. A small gusher was reported to have come in in the Akita district with a flow of 1,362 barrels. The production from the oil wells throughout Japan is small. Even the small wells may flow for a short time, but must soon be pumped. The average daily production for the Nishiyama field, the most productive one in Japan, is only 4·5 barrels, and the average for the entire Echigo oil district is only 2·25 barrels per day.

The oil varies somewhat in the different fields in the same district, and in the different sands of the same field. As a rule, the higher grade oils occur in the lower horizons. Generally speaking, the Japanese oils are heavy oils. A fair average for them is 30° Baumé. The highest grade oil is from the small Totomi district, which averages 42° Baumé; and the heaviest from the Akita district, which averages 20° Baumé.

At the end of 1912 there were 2,740 producing wells in Japan, of which 2,153 were drilled with American type machines; 301 were drilled with Japanese spring poles; and 286 were dug by hand. At this time 206 wells were being developed; 106 with American rigs; 76 with Japanese spring poles; and 24 were being dug by hand. Since the date of the above record, deeper wells have been dug further out on the slopes of the anticlines, and are proportionately more numerous than formerly in the active fields. In March, 1917, there were 2,840 producing wells in the Echigo district alone.

Of these, 2,236 were drilled with American type drills; 318 with Japanese bamboo springs poles, and 286 were dug by hand. The total production for March in this district of Echigo was 158,733 barrels.

Excepting for a small percentage which is held by the Government for the use of the Navy, all of the Japanese oil is refined, as it is too scarce and too valuable to use crude as fuel. The refineries are in the oil districts.

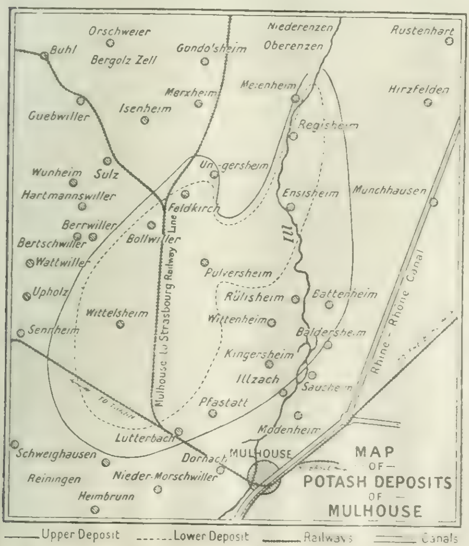
In 1915 there were eight companies in Japan reporting a production of over 5,000 barrels per year. They reported a total production of 2,932,097 barrels. Companies producing less than 5,000 barrels per year are not reported in the official statistics. The production and refining is practically in the hands of two companies, the Nippon Oil Company and the Hoden Oil Company. The Nippon Oil Company is credited with 1,628,291 barrels, and the Hoden Oil Company with 993,944 barrels. There were apparently in this year only 309,861 barrels produced by other oil producers, doubtless almost altogether from wells dug by primitive methods.

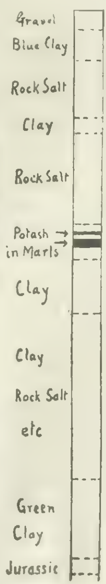
ALSACE POTASH DEPOSITS

The deposits of potash near Mulhouse, in the south of Alsace, were discovered after the annexation by Germany in 1871. Their loss is a serious economic blow to Germany. At the meeting of the Society of Chemical Industry held in London on November 4, Paul Kestner, president of the Société de Chimie Industrielle, read a paper on these deposits from which we extract the following brief notes.

The Alsace potash beds are situated in the south of the province, in the plain bounded on the south by the Jura, on the west by the Vosges, and on the east by the Rhine. Recent borings have shown that beds of the same formation are to be found beyond the Rhine The deposits extend as far as the suburbs of Mulhouse. They consist of two beds, of which the first, the more important of the two, has an average thickness of 4 metres and occupies an area of about 200 square kilometres. It is found at a depth of about 650 to 1,000 metres. The upper bed is less important both in area and thickness; it is fairly regularly parallel to the first and is 15 to 25 metres above it. The beds are formed for the most part of pure sylvine, or potassium chloride. They are situated below a deposit of rock-salt, which attains a thickness of 240 metres. The upper bed has an average content of 35% of potassium chloride and the lower one of 30%. The layers are nearly horizontal, which greatly facilitates the working. They are not subject to infiltration of water. The total contents of the two beds is estimated at about 700,980,000 cubic metres, that is to say, about 1,472,058,000 tons, the average content of the salts being 22% of potash (K_2O). The whole deposit represents therefore more than 300 millions of tons. But the most interesting fact is that the purity of the salt greatly surpasses that of all other known deposits of importance, and is notably very superior to that of Stassfurt. Refining is unnecessary for the salt intended for agriculture.

The first boring was made in 1904, near Wittelsheim, by prospectors working for Joseph Vogt and J. B. Grisez. Their object was to look for coal. At 358 metres, they reached beds of rock-salt; the boring was continued to a depth of 1,129 metres. Potash-bearing strata were reached without their occurrence being detected. It was only later, in examining samples of a dark red colour, that the presence of potash was recognized. Other borings showed that the deposit was of large extent. The company formed to work the discovery made 165 borings, and began working in the first shaft in 1910. This company, the Gewerkschaft Amelie, has founded affiliated companies in order to profit by the regulations of the German potash cartel, which allows a given output to each centre of extraction working of a concession of 1,800 hectares. At the end of the same year, the German company in Stassfurt, the Deutsche Kaliwerke, recognizing the value of the Alsatian beds and fearing the independent spirit of these new competitors, bought enough shares to secure for themselves the control of the Amelie company. They paid 30,000 marks for shares which had cost their owners 6,000. Another





SECTION OF BORE HOLE

group of French and Alsatian capitalists founded the Ste. Therèse company. This company obtained a certain number of concessions covering 5,000 hectares, and afterward bought most of the shares in two other companies which owned concessions adjacent to their own. The different concessions of the Ste. Therèse company have just begun to be worked. Two of the shafts have reached the deposit, and two are now being sunk. Two other German groups have acquired concessions and are carrying out development work. It may therefore be said that the potash basin of Upper Alsace is divided among four parent groups.

The German Potash Syndicate took care to limit the working of the Alsace deposit, and only allowed an output of 5% of the total German output. In order to safeguard the interests of the powerful shareholders of the mines of Northern Germany, the deposit furnishing the richer product and the mines which could be most easily and most economically worked were sacrificed to the poorer. In addition, vexatious regulations were made (which seem, however, to have been annulled shortly before the war) enacting, for instance, that Stassfurt should be taken as the basis from which transport charges were to be calculated whatever the destination might be. Thus, for Switzerland or for France, which are 30 kilometres from Mulhouse, the cost of transport was as high as for the 600 kilometres, as the crow flies, between their frontiers and Stassfurt. These tariffs were in force even for the countries adjoining the workings. The State had laid it down as a principle that potash must be considered as a national asset, and must, before everything else, favour the agriculture and industries of Germany. The defeat of Germany releases the Alsace deposits from this cartel. Their eventual control will no doubt be settled at the peace conference.

ZIRCONIA, ZIRKITE, AND FERRO-ZIRCONIUM.

At the meeting of the Ceramic Society, held at Swansea, a paper was presented by H. C. Meyer, of Philadelphia, entitled "Zirconia: its Occurrence and Application." This paper deals largely with the commercial form in which zirconia occurs, known as zirkite, and it mentions ferro-zirconuim, the steel alloy of which much is heard but of which little is known.

Literature on the technology and application of zirconium oxide has been amazingly stimulated by the war, not only in the United States but also in England. Probably we should be even more surprised at the applications which have been developed in Germany during the last four years, but unfortunately very little information of an authentic character has been available. As far back as the year 1913, Krupp's of Essen were experimenting with zirconia, presumably in the hope of developing its use as a steel hardening agent. At the same time, several German chemical manufacturers were producing pure white zirconium oxide free from iron, titania, and silica, at prices varying from 60 to 75 cents per kilogramme. In 1915, the writer spent much time in Brazil investigating the zirconia deposits, and, in a sojourn of over a month in the Caldas area, learned, from personal conversation with various well-informed landowners, that there had been an attempt by certain German interests to form a monopoly. Fortunately the sentiment in Brazil in the very beginning of the war was strongly pro-ally, and any marked activities on the part of German interests were not only frowned upon by the Brazilian Government but also by the public in general. A local representative of German interests became involved in certain legal difficulties in regard to the title of certain zirconium ore deposits, and was subsequently recalled to Germany.

Brazilian Zirkite Deposits. — Throughout this paper, wherever the word "zirkite" is employed, it is understood that it is not as the name of any particular mineral, but merely to designate the commercial ore of zirconium such as that furnished by the deposits near Caldas, being essentially a mixture of brazilite, zircon, and a new and unnamed zirconium silicate. This new zirconium silicate was under investigation by Dr. Orville A. Derby, former chief of the Brazilian Geological Survey, at the time of his death. Zirkite is a trade name registered in the United States Patent Office by the Foote Mineral Co. of Philadelphia.

There are but few commercial deposits of the unusual ores which present more interesting geologic as well as economic features than do the deposits of natural zirconium oxide in Brazil. The Caldas region, visited in 1915 by the writer, in which these zirconia deposits occur, is situated partly in the state of Minas Geraes and partly in the state of Sao Paulo. It is a mountainous plateau, the main elevation of which is about 3,600 ft. The surface is undulating, presenting differences in altitude of from 300 to 600 ft. The whole area is bounded on all sides by ridges rising abruptly from 600 to 1,200 ft. above the general level and forming a roughly elliptical enclosure with a major axis of approximately 20 miles in length and a minor axis of 15 miles. This peculiar arrangement of the higher ridges is very significant when coupled with the fact that the predominant rock of the plateau is a phonolite and the presence of highly mineralized thermal water of considerable medicinal value. (See Orville A. Derby, "Nepheline Rock in Brazil," in the Quarterly *Journal* of the Geological Society, August, 1887.) No thorough geological survey has been made of this area with a view to determining the origin of the zirconia. The character of the ore, however, and the formations seem to point to pneumatolytic agencies. A careful study of the relationship of the large masses of coarsely crystalline nephelite syenite in this area, with pronounced segregations of eudialyte, might throw some light upon this subject.

Zirkite can be roughly divided into two classes: First, alluvial pebbles ranging in size from ½ in. to 3 in. in diameter, generally carrying about 90 to 93% zirconium oxide. These pebbles, known as "favas," and having a specific gravity ranging from 4·8 to 5·2, are found along small stream beds and on the talus slopes of low ridges. Second, zirconia ore proper, or zirkite, which ranges in shade from a light grey to a blue black, the lighter coloured material carrying a higher percentage of zirconium silicate, as evidenced by analysis, which in some cases shows a minimum of 73% zirconium oxide. The blue black ore generally carries from 80 to 85% zirconium oxide. By careful sorting, however, a uniform grade carrying about 80% is produced. Prior to the investigations of Derby and Lee, this ore was considered identical with baddeleyite or brazilite. It has now been shown, however, that it is a mechanical mixture of three minerals, namely, brazilite, zircon, and a new and unnamed zirconium silicate carrying about 75% zirconium oxide. This new mineral has the same crystal form as zircon (67% ZrO_2), but is readily soluble in hydrofluoric acid while zircon is not affected, this being a characteristic differential test. The finely powdered mineral, on being treated with a weak solution of hydrofluoric acid, leaves a residue of minute, perfect, pyramidal crystals of zircon, the brazilite and new zirconium silicate going into solution. Several large outcrops of the ore occur on the extreme westerly edge of the plateau, one or two isolated boulders weighing as much as 30 tons. No extensive development work has yet been attempted, although several cross-cuts have been run to determine the width of the vein, and a few shallow prospect holes to determine the depth, but seemingly, through indifference of the owners, this development work was not completed. In some of the deposits the ore occurs in the form of gravel and large pebbles embedded in a reddish clay matrix greatly resembling a boulder clay. This is mined by open-cut methods. The clayey mass, on being exposed to the tropical sun and air, readily dries, and the zirconia can then be separated from the clay matrix by a coarse screen. Before shipment, it is thoroughly washed to remove the small percentage of ferruginous matter still adhering.

Most of the mines are many miles from the railroad. Horses for other than saddle purposes are practically unknown, and the ore is transported to the railroad station by ox carts carrying about one ton each. These carts are of the most primitive character, having large, solid, wooden wheels some 4 ft. in diameter and 6 in. in thickness. From 8 to 16 oxen are generally required for each cart, owing to the mountainous roads.

This very cursory examination of the zirconia deposits makes it unsafe to venture any conjecture as to the quantity of ore available. Suffice it to say, however, that the deposits have been traced for a distance of fifteen miles between Cascata and Caldas, and if surface indications are of any significance, are of vast extent.

Application as a Refractory.—The remarkable heat-resisting qualities of zirkite at once commend it as a refractory of the first order. Its high melting point, low coefficient of expansion, and low thermal conductivity make it an ideal lining for electric furnaces of either the arc or resistance type. The pure oxide, owing to the comparatively high cost of extraction and purification, is too costly at the present time for industrial uses on a large scale. Careful tests have shown, however, that zirkite is eminently fitted for such work.

To compete with the various other high-grade refractory bodies now used industrially, zirkite must necessarily possess certain refractory qualities lacking in its rivals, such, as for example, a higher melting point or greater resistance to chemical agencies. In other words, the initial cost of a zirkite lining, which is rather high as compared with, for example, magnesite brick, is more than offset by its low thermal conductivity and low coefficient of expansion.

There are many difficulties attending the manufacture of zirkite brick. Zirkite itself has little or no plasticity, and the initial experiments made by the author and several experienced firebrick manufacturers, show that the selection of the proper binder governs the melting point and fire shrinkage of zirkite brick. The high percentages of silica and iron oxide also play an important part in the behaviour of the material when subjected to high temperatures. It will be noted from the foregoing analyses that the only two oxides present which would be likely to cause a lowering of the melting point are silica and ferric oxide. The small percentage of titanium oxide present may or may not exert a fluxing action at high temperatures.

In preliminary work, small briquettes measuring 36 by 20 by 5 mm. were made from the following mixtures. These were thoroughly dried and burnt at a temperature of approximately 1,427°C. with the following results.

		Linear Shrinkage Per cent.
1.	Pure zirconium oxide (9[illegible]% ZrO_2)	9
2.	Water-ground zirkite (84% ZrO_2)	9
3.	S[illegible]ined zirkite (9[illegible]% ZrO_2)	9
4.	[illegible] of No. [illegible] and 7 grammes Dry Branch kaolin	12
5.	[illegible] zirkite, 80-mesh, and 40 grammes zirkite cement	3

Briquette No. 1, made from pure zirconium oxide analysing about 99% ZrO_2, yielded a sticky mass on mixing with water and was quite soft after drying. After burning, No. 1 was still in a soft condition and could be readily scratched with the nail. Briquette No. 2 consisted of zirkite carrying about 84% ZrO_2. As indicated, this material was wet-ground in a ball mill and thus reduced to an extremely fine state of sub-division. It was readily moulded into shape. Firing rendered the material extremely dense and of a flint-like hardness. Several briquettes were heated to redness and one end plunged into a beaker of water. This quenching test apparently left the material unaffected, as no cracks were developed. Briquette No. 3 was made from 95% zirconium oxide. This 95% product was prepared on a small scale from zirkite. Much of the silica and nearly all of the iron were removed by this refining, which yielded a light grey product. After firing, the briquettes presented a very dense structure and were extremely hard. Briquette No. 4 shows the bad effect of even a small percentage of a very refractory china-clay. Dry Branch kaolin is a pure white, washed clay, having a fusing point above 1,790°C. Briquette No. 5 was made from a mixture of 60 grammes coarse zirkite (material passing through an 80-mesh screen) and 40 grammes water-ground zirkite, or material similar to No. 2. The shrinkage in this case was extremely low. The briquette, after firing, presented a rather coarse, porous texture, but possessed considerable tensile strength. Whether these shrinkage figures would be much greater at higher temperatures it is difficult to say.

Tests made by G. T. Stowe at the Ohio State University, on using zirkite ground to 100 mesh and moulded into cones, showed no fusion at cone 35 (1,830°C). The material burnt with little warpage or shrinkage and showed only slight vitrification. With a view to finding a suitable bonding material, he used a mixture consisting of 95% zirkite, 100 mesh, and 5% of a highly silicious fireclay. This mixture was made into cones and subjected to a temperature of about cone 32 (1,770°C). Little warpage of shrinkage was noted and only slight vitrification. A mixture of 98% zirkite and 5% slacked lime proved that the addition of this latter oxide lowered the melting point markedly.

A series of tests made by R. C. Gosrow on zirkite gave the following interesting results. The tests were made in the form of small briquettes measuring 1¼ by 1¼ by 4 in. in a steel mould. The material was rammed in place with considerable pressure. Five such tests were made as follows: (1) Zirkite powder, bonded by 26 5° Bé $MgCl_2$ solution (concentrated from salt bittern). Mixed to consistency of a stiff mud and rammed. Dried 5 days—100°C. Dried 8 hours—150°C. Heated gradually to bright red and exposed to temperature 1,600°C in an electric arc furnace for two hours. The sample showed no fusion; corners sharp and hard; scratch glass; shrinkage slight; FeO and Fe adhere in molten condition; FeO showed corrosion; very dense; difficult to crack with bricklayer's hammer. (2) Zirkite powder, 50%; dead-burnt magnesia (electrically dead-burnt), 50%; bonded by 26·5° Bé $MgCl_2$ solution and mixed to hard, stiff mud and rammed. Dried same as No. 1. Heated to same temperature and for same time as No. 1. Fused to spongy mass, dark colour. The fusion was evidently caused by iron oxide and silica. (3) Zirkite powder, 10% ; dead burnt magnesia, 88%, 26.5 Bé $MgCl_2$ solution, 2%. Mixed to stiff mud and rammed. Dried and heated same as for No. 1. Hard, dense, compact brick ; sharp, hard corners ; positively no fusion ; showed no corrosion by FeO ; light brown colour. (4) Zirkite powder ; bonded by 30° Bé Na_2SiO_3 solution to form stiff mud and rammed. Dried and heated same as No. 1. No fusion ; extremely hard, dense ; interior appeared denser than exterior ; slight crack in interior, probably due to moisture. (5) Zirkite powder ; bonded by small amount of water in form of vapour, mixed to stiff mud and rammed. Dried and heated same as for No. 1. Compares to properties of No. 1. Showed same FeO corrosion.

With the exception of No. 2, which fused, the samples showed : (1) general corrosion by FeO in spots ; (2) slight shrinkage ; (3) withstood temperature changes from 500°C to 1,600°C without any cracking or spalling ; (4) no contortion or deformation at high temperatures ; (5) precaution necessary in choosing suitable binder, and also care to be used in mixing other refractory substances containing impurities as FeO, SiO_2, etc. ; (6) zirkite can be used equally with magnesia, and with less cost for linings, etc.

The results secured by Mr. Gosrow under test No. 3 appeared promising enough to warrant further investigation along this line. Preliminary tests indicate that magnesium chloride would be objectionable on a commercial scale. Hence, another binder was sought and ultimately found in water-ground zirkite. It was further considered that the dead-burnt magnesia (electrically dead-burnt) might be successfully replaced by ordinary calcined magnesite, such as is used for magnesite cement in flooring. This product carries about 93% magnesium oxide, with a small percentage of carbon dioxide, calcium oxide, and silica.

The following formulæ were used, by J. R. Adams under the author's supervision, in the making of several small briquettes, which were carefully dried and burnt at a temperature of approximately 1,427°C in a small muffle furnace: Formula 3A. 45 grammes zirkite (ground to pass through 80 mesh screen), 45 grammes magnesium oxide (calcined), 10 grammes water-ground zirkite. The briquettes after burning were of a brownish-yellow cast, with a rather loose texture, but quite resistant to abrasion and of a fair tensile strength. The fire shrinkage at the above temperature was approximately 8% linear measurement. One of the briquettes at a white heat was dropped in a beaker of water, but no cracks were developed and the material was apparently as solid as before quenching.

Formula 3B. 72 grammes zirkite (ground to pass through 80-mesh screen), 18 grammes magnesium oxide (calcined), 10 grammes water-ground zirkite. Briquettes made from this formula had very much the appearance of those produced by formula 3A. The fire shrinkage was approximately the same. The specific gravity was of course higher, owing to the greater percentage of zirkite present. The results of these tests were considered rather encouraging, and further investigations are now under way. The strong objection to the use of the magnesium oxide, particularly the calcined product, is the fact that it has an extremely high shrinkage. This of course is not true of the costly electrically shrunk magnesium oxide, but the tendency would naturally be toward the use of the cheaper calcined oxide.

As will be noted under fire shrinkage, briquette No. 4, mixed with a 10% bond of refractory clay, showed extremely high shrinkage. It was decided, however, to manufacture a few standard-size firebricks, using a 5% bond of Warrior Ridge clay, as mentioned above. The zirkite was ground to pass through an 80-mesh screen and thoroughly mixed in a dry pan with 5% of the before-mentioned clay. The mass was slightly moistened and formed into bricks in the same manner as is pursued in the manufacture of silica or chrome bricks. After thoroughly drying, these bricks were burnt in a silica brick kiln, at an estimated temperature of at least 1,649°C. No figures were secured as to the fire shrinkage, but even this small percentage of clay caused the bricks to soften at a temperature well below the fusion point of zirkite. The standard bricks made from the material weighed on an average 13 lb. each.

To determine the behaviour of the material when in contact with carbon at high temperatures, the following investigation was made by an experienced investigator, who requests that his name be withheld. A brick was made a part of one side of the trough of a granular carbon resistance furnace, the rest of the trough being made of magnesite brick, all being backed up by firebrick. A pyrometer tube was put in so as to give the temperature of the surface of the brick, next the carbon register, and temperatures read with a Wanner pyrometer. In about one half-hour after starting, the temperature was 1,800°C ± 25° and it was held between 1,750° and 1,850°C. averaging 1,800°C ±25° for 1½ hours. The furnace was then torn apart. The zirkite brick was just nicely red on the back (2½ in. from the resistor), while the magnesite bricks were much redder. From this and from the temperature of the firebrick backing when felt from time to time, it is plain that zirkite has a considerably lower thermal conductivity than magnesite, and quite probably the lowest of any available material that will stand 1,800°C. The brick, when put in place, had a slight crack, and this increased a little on heating, but not very badly. Magnesite bricks on both sides of it were badly cracked. A slight shrinkage was noted on the hot face, and the surface of the zirkite brick was slightly pitted and spongy. The spongy layer was only about ⅛ in. thick. The magnesite bricks were considerably more acted upon by the carbon than the zirkite bricks, their surfaces being eaten away uniformly over ⅛ in. Hence, as regards the action of carbon on the hot brick, the zirkite brick appears superior to magnesite, but inferior to carborundum

The zirkite brick was not supporting any weight, and only the inner face reached 1,800°C. The brick had not really fused nor flowed of its own weight, that is, it might not have failed under a cone test at 1,800°C. Yet when the brick was picked up with tongs, they sank into the hot face, under gentle pressure, to a depth of ½ in. The face of the brick was very plastic, and though it had not really fused nor flowed out of shape, the fact that the brick as a whole kept its shape was due to the stiffening effect of the comparatively cold back of the brick. If the whole brick had reached 1,800°C, and had been under any pressure, as in a wall with other courses of bricks resting on it, it would certainly have been pressed out of shape. It therefore appears that 1,800°C is the upper limit at which this brick (zirkite bonded with Warrior Ridge clay) could be safely used It is of course quite possible that a brick bonded with water-ground zirkite and free from clay bond might be stiffer and stand up at a higher temperature. Therefore, while this particular brick is not as refractory under furnace conditions as the reported melting point of zirkite would lead one to expect, it is still refractory enough to be classed among the half-dozen highest refractories; while not entirely free from shrinking and cracking, its behaviour in this respect is far better than magnesite, although not as good as carborundum. Its heat conductivity is apparently less than any other of the high refractories. Its behaviour in contact with carbon, while not perfect, is not so bad but that it can probably be controlled.

A satisfactory commercial process has now been perfected for the manufacture of zirkite brick. All standard shapes are now being made and are finding wide application in the United States for lining electric furnaces. Essentially, the American method of manufacturing zirkite brick consists in first passing the ore through a crusher and grinding to about 60 mesh in a dry pan, removing all particles running finer than 100 mesh by passing over inclined screens and bonding the resultant product with zirkite cement. About 50% of 60-mesh zirkite and 50% of zirkite cement constitute the refractory mass. This is made into a stiff mud with water and moulded in the same fashion as silica brick. Green zirkite bricks have to be dried very slowly, as otherwise they develop air cracks. Furthermore, great care should be exercised in setting them, as they are very brittle in the unburnt state. The percentage of loss is rather high, but the warpage and cracked bats can be used over again after regrinding in the dry pan.

Unfortunately, war conditions prevent the enumeration of the many uses to which zirkite is now being put as a refractory body. It is to be hoped that such information will not be lost, and that following the war there will still be a greater development in the uses of this new refractory.

Ferro-zirconium.—Various unauthenticated reports have been circulated in the United States as to the remarkable properties of German armour-plate, samples of which are said to have been analysed and found to contain zirconium. It has already been noted that Krupp's, of Essen, were prior to the war investigating zirconium, and it is interesting to note that the Brazilian Government reports show that in 1913 there was exported from that country 1,119 tons of zirconium ore. As there was no important consumption of the ore at that time in either the United States or England, it is natural to assume that nearly all of this tonnage went to Germany.

It has been known for some time and patents have been granted on the application of ferro-zirconium as a scavanger for removing nitrogen and oxides from steel. One of the most recent alloys of zirconium placed on the market, consists essentially of between 40 and 90% zirconium, with the residue mainly iron or an iron-group metal. Small percentages of titanium and aluminium are also introduced. This series of alloys is covered by United States Patent No. 1,151,160. It is claimed that the alloy is not subject to oxidation, is highly resistant to chemical reagents, and is readily malleable. It is suggested that one of the alloys in this series may find important application in the manufacture of drawn filaments for incandescent lamps. Such filaments are claimed to have the property of selective radiation; in other words, emit more light than corresponds to the temperature at which they are heated by electric current. This implies a considerably lower wattage per candle power than is now required by the average metal filament lamp. A typical analysis of some of the alloys produced under the above patent shows: zirconium 65%, iron 26%, titanium 0·12%, and aluminium 7·7%. The production of the alloys is accomplished either by reduction with finely divided aluminium together with the mixed oxides of iron, titanium, etc., or whatever metals it is desired to introduce into the alloy; or they can be produced by heating the mixed oxides in a graphite crucible in an electric furnace, using either zircon or zirkite as a source of zirconium.

Metallic Zirconium.—This has been produced in small quantities by Dr. C. James, of New Hampshire College. It is in the form of a greyish black, amorphous powder, which gives a powerful evolution of hydrogen when treated with hydrofluoric acid. When shaken near a flame the metal produces brilliant sparks, and small quantities can be readily ignited with a match. There are two other forms of metallic zirconium, namely, the crystalline form and the graphitic types. The crystalline form has a density of 6·4 and a melting point of 1,500°C.

Zirkite Ware.—The investigations of Dr. C. M. Johnson during the past few years have resulted in the manufacture of laboratory ware from zirkite mixed with other refractory bodies. Zirkite filtering crucibles, muffles, combustion tubes, combustion boats, pyrometer tubes and Kipp generators with replaceable units, are now on the market at prices comparing favourably with like articles of chemical porcelain or fused silica. Zirkite combustion tubes have been reported running in steel testing laboratories on carbon determinations for as long a period as three months, being used constantly day and night. Owing to the composition of these tubes they are not attacked by basic substances, do not devitrify, and are gas-tight up to temperatures of 1,000°C.

Summary.—The following is a summary of the commercial uses of zirconium; it will be noted that mention is made of other uses in addition to those described in foregoing paragraphs:

(*A*) (1) The metal alloyed with iron is now finding application in the steel industry as a hardening agent; (2) As a scavenger for removing nitrogen and oxides from steel; (3) In the manufacture of drawn filaments for incandescent lamps; (4) Alloyed with nickel for the production of high-speed cutting tools.

(*B*) (1) The carbide is employed as a filament for incandescent lamps; (2) As an abrasive.

(*C*) (1) The oxide is employed as a refractory body either in its pure form or in the semi-purified state known as zirkite; (2) In the manufacture of zirkite bricks; (3) In the manufacture of small highly refractory utensils for laboratory purposes; (4) Combined with yttrium earth oxides for the manufacture of Nernst glowers; (5) As a substitute for calcium oxide in limelight cylinders and in the manufacture of pencils for the Blériot automobile headlight; (6) As an acid-proof enamel; (7) As a substitute for bismuth salts in making X-ray photographs; (8) As an addition to fused silica ware for the prevention of devitrification.

(*D*) (1) The nitrate has been employed as a food preservative; (2) In the lighting fluids used in the manufacture of incandescent mantles.

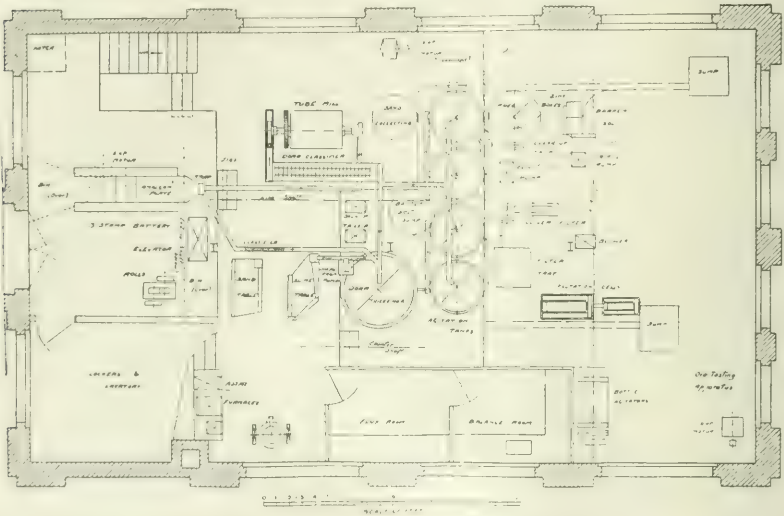
(*E*) (1) The basic acetate is employed for weighting silks.

Ireland's Mineral Resources. — In modern times, Ireland has not been an important producer of minerals, and little is known of current production and possible resources. We extract here some notes on the subject contained in Sir Lionel Phillips's report on the mineral industry of the United Kingdom.

Lead is not mined in Ireland at present, the last substantial producers being the Glendalough and Luganure mines in County Wicklow, which closed down in 1892. The following mines were examined by engineers for Sir Lionel Phillips's Department Glendalough and Luganure, in Wicklow, Barrystown, in Wexford; Ballysodare, in Sligo; Ballycorus, in Dublin; Drumreen and Keeldrum, in Donegal; and Burreen in Clare. As a result a limited expenditure was sanctioned on the Glendalough and Luganure mines, in order to extend the dressing plant treating dump material and to reopen part of the old workings. No zinc is mined in Ireland, though the Department's engineers saw mines in Sligo and Clare where blende is found in association with galena. At one time Ireland was a big producer of copper and pyrites, the Knockmahon and Berehaven mines being noted for copper and the Avoca mines for pyrites. Of recent years production has been practically non-existent. A dozen mines were examined by the Department's engineers in Tipperary, Waterford, Cork, and Wicklow, but only the Avoca and Berehaven mines warranted reopening during the war. As regards antimony deposits, a small mine at Clontibret, Monaghan, that used to be a producer, was examined, and a loan was granted for reopening. Bauxite is mined at five places in Antrim and occasionally at one place in the adjoining county of Derry. It is not in great demand as an ore of aluminium, owing to its high silica content, but is used in the manufacture of sulphate of alumina. Sir Lionel Phillips's report does not touch on iron and coal, but information is to be published shortly. Other mineral products mentioned are diatomite found at Toomebridge, Antrim; barite, worked at four mines in Cork and one mine in Sligo; rock salt and brine, worked in Antrim, and high-quality glass sands on Muckish mountain in Donegal, and elsewhere.

Haileybury School of Mines.—In the October *Bulletin* of the Canadian Mining Institute, A. E. Flynn, A.R.S.M., gives an account of the ore-dressing laboratory at the Haileybury School of Mines. Haileybury is about five miles north of Cobalt, and is in the centre of the Northern Ontario mining district, comprising Cobalt, Porcupine, Kirkland Lake, Gowganda, and other outlying districts. The School provides an elementary and practical mining education for boys of high-school standing and also includes courses for miners, mill-men, prospectors, and others engaged in mining work. There is a demand at the mills for young men with a practical technical training, to assist in the control of mill operations and to give intelligent assistance in research work. To meet this demand the present ore-dressing plant was designed and is now being completed. The main idea in the design has been to provide a plant capable of treating ore by amalgamation, gravity concentration, flotation, and cyanidation, using a single process, or using the processes in any combination. By this flexible arrangement it is possible to duplicate the work of the various mills of the district and also to carry out original research work. Also, mine operators will be given facilities for developing a process for treating their ore under their own supervision at the School.

The equipment is on a small scale, and capable of treating 1 ton per day. The laboratory is housed in a substantial two storey brick building, 60 by 35 ft. In the same building there is an assay office, carpenter's shop, machine shop, and blacksmith's shop, and a small analytical laboratory. The upper floor contains a 4 by 6 in. Sturtevant crusher, trommel, elevator, and



PLAN OF THE ORE-DRESSING LABORATORY, HAILEYBURY SCHOOL OF MINES

Braun pulverizer, all run by a 5 h.p. motor. The ore, after crushing and sampling, is passed to either the stamp bin or rolls bin. The stamps are 3 head, 250 lb., fitted with inside amalgamation plates and an outside plate, 4 by 2 ft. These stamps are made by Fraser & Chalmers for small prospects, and are admirably suited for the purposes of the School. The rolls are 8 by 5 in. Sturtevant laboratory rolls, placed to run in the mill circuit, and to be used for sample crushing. The stamps and rolls are on an intermediate floor, and are run by a 5 h.p. motor. The concentration section contains a small two-compartment jig, the compartments being 18 by 9 in., and a spitzkasten giving two sand products and a slime product. There are two concentrating tables, a Wilfley and Deister respectively, for coarse and fine sand, a tube-mill for re-grinding, and a Dorr classifier. The flotation department contains Callow plant, consisting of Brown agitator, a rougher cell 3 ft. by 9 in. canvas area, and a cleaner 2 ft. by 6 in. canvas area. The cyanide department contains a sand leaching vat, four agitators, an Oliver filter, and clarifying press. The agitators are 4 ft diameter and 2 ft. deep, and the Oliver filter has a drum 3 ft. in diameter and 6 in. face. The zinc-boxes are 9 by 9 in., and zinc shavings and zinc dust can be used alternatively. Sodium sulphide is also used for precipitating silver The installation includes also a Dorr thickener, three centrifugal pumps, a diaphragm pump, and a triplex pump. The total horse-power used is 35, and in addition 10 h.p. is supplied to the carpenter's shop and machine shop.

SHORT NOTICES

Mine Signalling.—The *Iron & Coal Trades Review* for December 6 describes the Dearle and Holmes apparatus employed in connection with mine signalling at the Grassmore collieries, and made by John Davis & Son, of Derby.

Steam Shovels.—The *Engineering and Mining Journal* for November 30 describes the Armstrong mechanical shovel, made by the Armstrong Company, Vulcan, Michigan.

Pit-Props.—In the issue of December 20, the *Iron & Coal Trades Review* gives an account of the Amocab ferro-concrete pit-prop.

Electric Haulage.—In the *Colliery Guardian* for December 20, L. Fokes gives some practical notes on three-phase electric haulage equipment.

Mining Laws.—In the *Colliery Guardian* for December 6, Captain David Bowen commences a series of articles on mining law and economics.

Coal Washer.—At the meeting of the South Wales Institute of Engineers in December, Professor George Knox read a paper describing the Draper coal washer.

Dry Concentration.—In the *Engineering and Mining Journal* for November 23, T. Shiras describes an installation of Sutton-Steele dry-concentration tables in operation in the Arkansas zinc-lead district.

Dry Concentrator.—The *Engineering and Mining Journal* for November 30 describes the Ideal dry concentrator, made by the Ideal Company, 140, Nassau Street, New York.

Silica Bricks.—In the *Iron & Coal Trades Review* for December 6, C. S. Graham, of Scunthorpe, Lincoln, writes on the changes in silica bricks due to conversion to allotropic forms of SiO_2.

Quicksilver in Italy.—*Chemical and Metallurgical Engineering* for December 1 prints an article by R Sterner Rainer on quicksilver metallurgy at Monte Amiata, Italy.

Sulphur in Texas.—In the *Engineering and Mining Journal* for December 7, Kirby Thomas describes the Trans-Pecos sulphur deposits, in Texas. We briefly referred to this deposit in our issue of November, 1917.

Mount Cannindah.—The *Queensland Government Mining Journal* for September contains a description by Lionel C. Ball, Government Geologist, of the Mount Cannindah copper mines.

Katanga Railway.—The *Engineer* for December 13 contains an article, illustrated with maps and photographs, of the Katanga Railway, connecting the Rhodesian railways with the Congo River.

Indian Water Power.—The *Engineer* for December 15 contains a paper, illustrated by maps, of the hydro-electric power installations and schemes in India, to which references have been made in our columns recently.

Progress in Mineralogy.—In the *Geological Magazine* for January, G. T. Prior, of the Natural History Museum, reviews the progress of mineralogy from 1864 to 1918.

RECENT PATENTS PUBLISHED.

13,617 of 1917 (120,748). J. V. and W. A. CLARKE, London. Method of preparing thorium nitrate from monazite.

16,559 of 1917 (120,610). J. A. YEADON and T. WHITAKER, Leeds. In smelting in a blast-furnace, introducing a quarter of the fuel required in dust form with the blast, thus reducing the amount of first class expensive fuel required.

16,741 of 1917 (111,845). W. G. HENSHAW, F. W. HUBER, and F. F. REATH, San Francisco. A method of dissolving potash salts from cement dust by leaching with water, the particular object being to prevent the formation of insoluble lime-potash sulphate.

17,161 of 1917 (120,772). Dr. A. L. SIMON, London. Improvements in inclined screens consisting of angle bars, suitable for separating slate from coal.

17,892 of 1917 (120,654). E. CORTESE, Alexandria, Egypt. A roasting furnace having an inclined hearth, the upper feeding end being more steeply inclined than the lower part.

18,349 of 1917 (120,994). H. A. BURNS, London. In the electrostatic precipitation of dust from gases, means for preventing its deposition on the electric connections and consequent short-circuiting.

18,651 of 1917 (120,811) H. W. FAUST, Seattle, U S.A. Improvements in jigs, having for the object the prevention of swishing and wave motion, and economy in the amount of water employed.

1,646 of 1918 (113,097). K. P. LUND, Sulitelma, Norway. In Marathon grinding mills, that is to say mills in which rods are used instead of balls, making the mill and the rods conical, the thickest ends being at the entrance, in order to give more weight to the crushing of the larger pieces of ore.

2,936 of 1918 (114,303). E. S. BERGLUND, Trollhattan, Sweden. An electric furnace for smelting lead ores, containing a molten lead seal which absorbs lead vapours and so prevents loss.

3,767 of 1918 (120,838). P. C. and E. E. DUTT, Jubbulpore, India. Process for extracting alumina from bauxite or clay by roasting with calcium chloride in presence of arsenious oxide vapour, and subsequently reacting on the aluminium chloride and calcium aluminate produced.

13,436 of 1918 (121,101). J. LYTLE, Liverpool. Making arsenate of lead by grinding lead carbonate in a strong solution of arsenic acid.

14,359 of 1918 (120,869). B. DAWSON, Bradford. Improvements in plant employed in the manufacture of nitric acid.

NEW BOOKS

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine* 723, Salisbury House, London Wall, E.C 2.

Popular Oil Geology. By Victor Ziegler, Professor of Geology and Mineralogy, Colorado School of Mines. Pocket size, 144 pages, with many illustrations and tables. Price $2 50. Golden, Colorado C. H. Merrifield.

The term "popular," as applied to a work dealing with a technical subject, is usually anathema to the trained scientific worker. From this point of view, one would wish that the author had chosen a title more worthy of the book, such as, "a précis of our present knowledge of oil geology."

The volume is divided into chapters as follows: I, the rise and development of the petroleum industry; II, the composition and properties of oil and gas; III, the origin of oil and gas; IV, rocks and their properties; V, stratigraphic geology; VI, the arrangement and structures of rocks; VII, the reservoirs of oil and gas; VIII, the laws of migration and accumulation of oil and gas; IX maps and their uses; X. oil structure and oilfields; XI, popular fallacies in oil geology; XII, prospecting and developing oil lands; XIII, oil shales and their utilization; XIV, oil investments. A glance through the titles of these chapters shows their comprehensive nature. In a small work of this kind it is impossible to discuss in detail any of the particular subjects of the chapters, but in all of them the main points are defined in clear and concise language, giving to the student a sound general knowledge of the subject; and the last chapter is full of sound commonsense advice to all who are, or wish to be, financially interested in oil properties. It is, in fact, a work well worthy of its distinguished author.

E. Lawson Lomax

The Mineral Industry, Vol. 26, 1917. Edited by G. A Roush and Allison Butts. Cloth, large octavo, 920 pages, illustrated. Price 50s. net. New York: McGraw-Hill Book Co.; London: Hill Publishing Company, Ld.

It is always a pleasure to receive this yearly volume We reviewed the 25th volume a year ago at some length, giving a history of the work and expressing our everlasting thanks to the many eminent engineers and metallurgists whose collaboration produces these invaluable volumes. In the present volume we see many old familiar names, such as W. R. Ingalls, who writes on zinc, H. O. Hofman, who records progress in lead metallurgy, G. F. Kunz, the authority on precious stones and metals of the platinum group, J. W. Richards, who writes on aluminium, R. H. Richards, the doyen of ore dressers, Walter Harvey Weed, who pays particular attention to copper deposits, and E. P. Mathewson, who writes on nickel The only English contributor is Baliol Scott, the editor of *The Mining Journal*, who appropriately takes tin under his charge. In spite of all the present talk about indexing and co-ordination of technical literature, we doubt whether anything better will ever be done for the mining engineer than is already being done by the contributors to the Mineral Industry.

Methods of Air Analysis. By J. S. Haldane, M.D., F.R.S. Second Edition. Cloth, small octavo, 140 pages, illustrated. Price 6s. 0d. London: Charles Griffin & Co. Ld.

Dr. Haldane has done much for the benefit of the worker in the mine and the factory, by indicating methods and means for improving the health conditions. Mining engineers know him well as an authority on air, and on diseases prevalent underground. His handbook on air analysis has been helpful, as it gives simple methods of investigating the condition of the air, and describes these methods in considerable detail so that they can be readily understood and undertaken. The second edition, now published, contains accounts of several new methods, among which we note the Kotze device for estimating dust.

The Iron and Steel Chemist. By Professor R. Namias, Milan. Cloth, pocket size, 240 pages, illustrated. Price 5·50 lira. Milan: Ulrico Hoepli.

This book is devoted to the analysis of steel and products of the iron and steel industries; also of the raw materials and auxiliary products employed in steel and cast-iron foundries. In addition it contains some considerations with regard to the constituents and impurities of steel and their influences. We quote from the author's preface: "The war has given an enormous impulse to the steel industry. Steel works have been multiplied everywhere, and especially steel works based on the employment of the electric furnace, which permits of the most varied products with even relatively modest installations. The exigencies required by the production of war material have brought into evidence the immense importance of the chemical control of the materials and of the products; and nowadays most of the establishments connected with the iron and steel industries have recourse very freely to chemical analysis. In the production of electric steel, chemical control is not only useful, but indispensable, because it is this which guides the founder. When, with the auspicious return of peace, steel works and cast-iron foundries may once more be directed into fruitful channels, this chemical application will not be without effect in improving and rendering more economical the production of iron and steel material, on which the influence of empiricism rested too heavily before the war. The author of this manual, who has been engaged in metallurgical chemistry and metallurgical chemical analysis for more than 25 years and who is acquainted by long practice with all the analytical processes, has thought he would be carrying out a useful and timely piece of work by collecting together in this book all the best methods studied and checked by himself, bringing into evidence the causes of errors and the method of eliminating them."

Italy is now going forward in connection with iron and steel, and this little book should help those engaged in the work to follow the lead of the countries that are bigger producers, on the lines of scientific research.

COMPANY REPORTS

Sulphide Corporation.—This company was formed in 1895 to purchase the Central mine at Broken Hill, and to treat the lead-zinc-silver ore by the Ashcroft leaching and electro-deposition process. On this process not proving successful, reversion was made to mechanical concentration for the purpose of extracting a lead concentrate. Subsequently the Minerals Separation process was adopted in order to extract a zinc concentrate. A lead smelter was established at Cockle Creek, New South Wales. A subsidiary company, the Central Zinc Co., was formed to establish a zinc smelter at Seaton Carew, County Durham, and recently that company was absorbed. The report for the year ended June 30 last shows that the output at the mine was less than normal owing to strikes which lasted for twelve weeks. The ore raised and sent to the mill was 126,726 tons, averaging 14.6% lead, 17% zinc, and 13.1 oz. silver per ton. In addition, the mill treated 34,960 tons, averaging 11.9% lead, 7.4% zinc, and 8.1 oz. silver, from the Junction mine, and 387 tons, averaging 11% lead and 18 oz. silver, from the Pinnacles mine. The yield of lead concentrate was 27,579 tons, averaging 64% lead, 9% zinc, and 42.8 oz. silver. The yield in the zinc section was 45,462 tons of zinc concentrate, averaging 45% zinc, 8.8% lead, and 13.3 oz. silver. This latter concentrate was sent to the de-leading plant, where there were produced 42,761 tons of zinc concentrate, averaging 47% zinc, 5.9% lead, and 12 oz. silver, and 2,410 tons of lead concentrate, averaging 60.5% lead, 12.8% zinc, and 36.8 oz. silver. At Cockle Creek, 93,432 tons of lead concentrate, purchased ores, by-products, and fluxes was charged into the furnaces, and 27,931 tons of lead bullion, containing 24,847 oz. gold and 2,552,748 oz. silver was produced. In addition, 21,658 tons of superphosphate was manufactured. At Seaton Carew, no concentrate from Broken Hill was received owing to the stoppage of shipping. There were treated 2,100 tons of concentrate from stock, and 7,809 tons obtained in Great Britain, or allocated from other sources by the Ministry of Munitions. The amount of ore roasted was 9,613 tons, of which nearly all was treated in hand-stirred furnaces, the mechanical roasting plant only coming into operation in June. The smelter treated 9,909 tons, and produced 3,155 tons of zinc, together with 122 tons of zinc dust. The retort residues were for some time treated on tables for the recovery of silver-lead concentrate, but the purchased ore was so low in silver and lead that this practice was suspended when the company's own zinc concentrate was exhausted. At the Central mine, the chief development was in the 1,400 ft. level where the ore-body was proved to be 40 ft. wide, of fairly average grade. The company's accounts show a net profit, after full allowance for taxes and depreciation, of £326,399, out of which £150,000 was paid on the preference shares and £112,500 on the ordinary shares, the rate being 25% in both cases.

Broken Hill South.—The report of this company covers the half-year ended June 30 last. During this period, 128,400 tons of ore was sent to the mill, averaging 15% lead, 14.6% zinc, and 7.9 oz. silver per ton. At the lead concentrator, 21,423 tons of lead concentrate was extracted, averaging 67.1% lead, 7.5% zinc, and 24.9 oz. silver; the other products were 78,831 tons of zinc tailing, averaging 17.9% zinc, 3.3% lead, and 3.8 oz. silver, and 19,136 tons of slime, averaging 11.3% lead, 13.7% zinc, and 8.8 oz. silver. The zinc tailing was delivered to the Amalgamated Zinc (De Bavay's) for treatment, and 20,069 tons of old zinc tailing, averaging 17.4% zinc, 6.4% lead, and 4.2 oz. silver, was delivered to the Zinc Corporation. The current slime was treated at No. 1 section of the slime-flotation plant, where 2,773 tons of lead concentrate was produced, averaging 61% lead, 7.7% zinc, and 51.3 oz. silver. The zincy residue is being stored for future treatment, as there is no market at present for zinc concentrate. No. 2 section of the plant has recently been started to work on accumulated slime. Development has continued to give encouraging results. In particular the exploration of the southern section by means of bore-holes from the 1,170 ft. level may be mentioned. The reserve has been maintained at about 3,500,000 tons. The company also has the following accumulations awaiting treatment: 794,789 tons of old tailing, for delivery to the Zinc Corporation, averaging 16% zinc, 5.5% lead, and 3.4 oz. silver; 442,932 tons of slime, averaging 10.8% lead, 14.2% zinc, and 6.1 oz. silver; and 67,297 tons of de-leaded slime residues averaging 13.8% zinc, 2.7% lead, and 1.5 oz. silver. The accounts show credits of £426,305, and a mining profit of £216,884. Out of this balance, £50,000 was placed to the account for new plant, and taxes and administration absorbed £55,000. Debenture interest took £5,715, and £120,000 was distributed as dividend, being at the rate of 12s. per £1 share.

British Broken Hill.—This company was formed in 1887 to purchase Blocks 15 and 16 from the Broken Hill Proprietary. In early days the property was not one of the most successful of the silver-lead-zinc mines of the district. The capital was reduced and new funds subscribed on two occasions, and mining operations were twice suspended owing to the low prices of the metals. In 1912 a new ore-body was discovered, which revived the fortunes of the company. On the outbreak of the war the mine was closed, and it was reopened in January, 1917. During this period of idleness the metallurgical plant was reorganized, and the latest practice in flotation introduced. An outline of the present plant is given elsewhere in this issue. The report for the half-year to June 30 last shows that 2,499 tons of carbonate ore, averaging 28.4% lead and 5.6 oz. silver per ton, and 111,321 tons of sulphide ore, averaging 12.2% lead, 11% zinc, and 7.2 oz. silver, were raised. At the lead mill, the sulphide ore yielded 17,127 tons of concentrate, averaging 61.5% lead, 7.5% zinc, and 27.1 oz. silver. At the zinc plant there was treated 85,052 tons of tailing, averaging 11.5% zinc, 2.9% lead, and 3.3 oz. silver, for a yield of 14,980 tons of zinc concentrate, averaging 45.2% zinc, 8.4% lead, and 10.6 oz. silver. Slime, to the extent of 9,111 tons, and averaging 12.2% zinc, 5.9% lead, and 6 oz. silver, was stacked for future treatment. The lead ore and concentrate was delivered to the Broken Hill Associated Smelters, and the zinc concentrate delivered to, or held for, the Zinc Producers' Association. The accounts show a net profit of £114,783, out of which £93,750 has been distributed, being at the rate of 5s. per share, free of tax. The share capital consists of 315,000 ordinary shares of £1 each and 60,000 privileged shares of 8s. each. George C. Klug is consulting engineer, and Cyril J. Emery is manager.

Yuanmi Gold Mines.—This company was formed in 1911 by the Oroya Exploration Company to acquire a gold mine in the East Murchison goldfield, West Australia. Dividends were paid in 1913 and 1914, but developments have been disappointing since. James Brothers are the consulting engineers, Leslie B. Williams is the manager, and John A. Agnew is on the board. The report for the year ended June 30 last shows that 24,311 tons of ore was treated for a yield of gold worth £56,104. The working cost was £63,900, and the year ended with an adverse balance of £7,517, bringing the total deficit to £37,936. Owing to scarcity of labour, it was not possible to run the plant to capacity, and the cost of supplies has increased. The development on the 7th level has not so far met the ore-body.

Menzies Consolidated Gold Mines.—This company was formed by C. Williamson Milne in 1895 to acquire gold-mining properties at Menzies, in the North Coolgardie goldfield, West Australia. R. Goninon is the manager. Dividends of 2½% each, on a capital of £224,015, were paid during the four years 1914 to 1917. The report for the year ended July 31 last shows that 24,871 tons of ore was sent to the mill, where gold worth £52,440 was obtained by amalgamation, cyaniding, and in concentrates. After allowing for taxes and depreciation, the balance of profit was £138. The scarcity of efficient labour and the increase in the cost of materials have hit the company, and the future is obscure. The ore reserve is estimated at 103,767 tons averaging 35s. 9d per ton, as compared with 109,344 tons averaging 36s. 7d. the year before. The 18th level has proved disappointing so far. It is intended to sink 200 or 250 ft and open a 19th level.

Mount Elliott.—This company has its headquarters in London and operates a number of copper properties in the Cloncurry district of Queensland. It has recently been the victim of unsatisfactory quality of labour. During the last quarter of 1917 the smelter was closed, with the object of modifying the plant so as to reduce the amount of labour required The plant started again on January 16, 1918, but in May the men went on strike until July 1. The report for the year ended June 30 last shows that, during the time of operation, the smelter treated 51,952 tons of ore, for a yield of 2,322 tons of blister copper, and that this was refined at the Bowen plant, giving 2,292 tons of copper. The financial position of the company has been adversely affected by the labour troubles and stoppages, and the accounts show a loss for the year of £56,890. W. H. Corbould, the company's representative in Australia, and A. E. Strick, the mine superintendent, write in an encouraging tone with regard to the available ore, though naturally the labour position gives little hope for regular production and profits. Mr. Strick gives the following estimates of ore reserves ; Mount Elliott, 600,000 tons averaging 3% copper, and 10,000 tons 10% ; Hampden Consols, 450,000 tons 4% ; Great Australia, 110,000 tons 2½%, and 93,000 tons 4% ; Dobbin, 70,000 tons 5% ; Mount Oxide, 300 000 tons 10% ; Argylla, 200,000 tons 4% ; Lady, 28,000 tons 5%.

Taquah Mining & Exploration.—This company was formed in 1888, as the Taquah & Abosso Gold Mining Co., to acquire gold-mining properties in the Gold Coast Colony, West Africa. From 1892 to 1898 milling was conducted on a small scale. In 1901 the company was split, and the Abosso mine worked by a subsidiary. The control passed to the Oceana Consolidated in 1910, and additional capital was then provided for development. Dividends have been paid regularly since 1914. The report for the year ended June 30 shows that 62,527 tons averaging 56s. 9d. per ton was mined and sent to the mill, together with 2,302 tons of development ore. The yield of gold was £180,785, being a recovery of 98%. After allowing for depreciation, the net profit was £43,320. No dividend was received from the holding in the Abosso company. The shareholders received £48,434, being at the rate of 12½%. The development at the mine has continued to be satisfactory, and the reserve has been well maintained at 213,469 tons averaging 57s. per ton. It is notable that the working cost has not increased during the past year. Under present conditions, this is a result that reflects considerable credit on the manager, G. W. Campion.

Abosso Gold.—This company is a subsidiary of the Taquah, and was formed under circumstances detailed in the previous paragraph. Dividends were paid from 1906 to 1911, and from 1913 to 1916. The report for the year ended June 30 last shows that 102,256 tons of ore was sent to the mill, and that gold worth £152,320 was extracted, the yield per ton being 29s. 9d. In addition, £2,491 was extracted from 6,921 tons of accumulated slime. The working cost was £148 458, leaving a balance of profit of £6,842. This balance was, however, converted into a loss by the necessity for writing off £7,678. Development during the year has continued to disclose ore of average grade, and the reserve is calculated at 280,330 tons averaging 33s. 3d., as compared with 265,400 tons averaging 32s. 6d. the year before.

Glynn's Lydenburg.—This company was formed in 1895 to acquire a gold mine on the Sabie river, near Pilgrim's Rest, in the Lydenburg district of the Transvaal. The control is with the Central Mining group, and G. C. Damant is manager. Dividends averaging 20% have been paid continuously since 1897. The report for the year ended July 31 last shows that 46,964 tons was sent to the mill. The yield by amalgamation was 7,748 oz , and by cyaniding 13,612 oz., making a total of 21,360 oz., worth £88,756, or 37s. 9d. per ton. The working cost was £62,520, or 26s. 7d. per ton, leaving a profit of £26,235, or 11s. 2d. per ton. The shareholders received £27,625, being at the rate of 16¼%. The floods of a year ago interfered with the output and development, and caused a rise in cost. The present conditions are more favourable. The ore reserve is estimated at 138,928 tons averaging 9·8 dwt. per ton, as compared with 109,126 tons averaging 8 9 dwt. the year before. This increase is due almost entirely to the good results obtained in the Compound Hill section, where the reserve has been increased from 19,911 tons averaging 11·2 dwt. to 55,113 tons averaging 12·2 dwt.

Luipzard's Vlei Estate & Gold.—This company was formed in 1888 by the Consolidated Gold Fields to work a gold-mining property in the Far West Rand. Milling started in 1898, but was suspended on the outbreak of the Boer war, not to be resumed until 1906 In 1909 the adjacent Windsor mine was absorbed. In 1912 the control passed to L. Ehrlich & Co. The property consists of four sections, two on the Main Reef Series, and two on the Battery Reef to the south Small dividends were paid in 1908, 1909, and 1916. The report for the year shows that 246,910 tons averaging 5 02 dwt. per ton was milled, for a yield of gold worth £249,964, being 20s. 3d. per ton. The result of the year's work was an adverse balance of £3,448, and in addition, £8,192 has been written off for depreciation. The company has been badly hit by the increase in working cost, and also by the floods of a year ago. It has been necessary to revise the estimate of reserves, and to eliminate certain of the blocks of low-grade ore. The figures at June 30 were 645,034 tons averaging 5·51 dwt., fully developed, and 48,909 tons averaging 6·1 dwt , partly developed.

Middelburg Steam Coal & Coke.—This company was formed in 1902 to acquire coal lands in the Middelburg district of the Transvaal. Alan Cadell is chairman, A. T. Macer is managing director, and E. M. Goodwin is manager at the mine. The report for the year ended June 30 last shows that 274,802 tons of coal was mined. This is less by 34,753 tons as compared with the previous year. The fall is due partly to scarcity of railway trucks, and partly to an influx of water caused by excessive rainfall. The cost of materials and labour has risen, without any corresponding increase in the price of coal. The net profit was £12,989, as compared with £17,161 the year before. The dividends absorbed £3,244 on the preference shares, and £7,491 on the ordinary shares, the latter being at the rate of 7½%. During the year, additional property on the farm Blesbloklaagte has been acquired.

Cape Copper.—This company has worked copper mines in Little Namaqualand, Cape Province, since 1863. It ships ore and matte to the smelter at Britonferry, South Wales. About a year ago, however, shipping restrictions were imposed, preventing the export of the mine and smelter products. The report now issued covers the year ended April 30 last in the Cape Province and the year ended August 31 in this country. The amount of ore mined at O'okiep was 7,472 tons averaging 11·7%, and at Nababeep 19,914 tons averaging 4·05%. The smelter was not running more than 170 days owing to shortage in the coke supply. The mines and metallurgical plant were worked as far as possible, though latterly it was impossible to bring the output to market. At the O'okiep mine, the manager cannot give any estimate of the ore still available. At Nababeep the reserve is calculated at 90,000 tons averaging 5%, the same as the year before. The company acquired a copper property at Rakha Hills, Chota Nagpur, India, a few years ago, and has erected a smelter and converter plant. The blast-furnace and the first converter were put in commission during the year under review, but the short supply of coke has prevented any regular campaign. The ore reserve is estimated at 453,876 tons averaging 3·69% copper.

Cornwall Tailings.—This company was formed in 1910 to treat old dumps at the Carn Brea and Tincroft mines, near Camborne, Cornwall. Arthur Richards is managing director. The report for the year ended February 28, 1918, just issued, shows that 75,962 tons of tailing was treated, averaging 12·45 lb. of metallic tin per ton. The yield of tin concentrate was 236 tons. The percentage of recovery was 35%. The sales realized £28,854, and the net profit was £4,192. The dividend absorbed £3,743, being 5%, less tax, and, since the end of the year under review, another dividend of the same amount has been paid. Owing to lack of labour, the amount of material treated was not much more than half the normal. The working cost was 5s. 2d per ton, as compared with 4s 2d. the previous year. At February 28, the remaining tailing amounted to 320,000 tons, but only 50,000 tons of this was estimated as workable.

Central Chili Copper.—This company was formed in 1894 to work the Panulcillo copper mine, near Coquimbo, Chile, that had been previously operated for many years by the Panulcillo Company. Neither the present nor the old company has given much return on the capital invested. The report for 1917 shows that 30,555 tons of ore, averaging 3·8% copper, was mined, and of this, 25,646 tons was sent to the smelter. In addition, there was treated 31,223 tons of custom ore averaging 8¼%. The matte produced contained 2,817 metric tons of fine copper, 52,227 oz. silver, and 1,196 oz gold. The loss for the year was £43,906, which deducted from the balance brought forward left a balance in hand of £7,502 at the end of the year. The output of metals was about the same as during the previous year. The unfavourable financial position was due to the low prices realized in New York and to the increased cost of working and of freight. In May, 1918, the shipping restrictions prevented export of matte, so smelting and the purchase of custom ore were suspended. Attention has since been given to the development of other properties in the neighbourhood, some owned by the company and some held on option.

Frontino & Bolivia Gold.—This company was formed in 1864 to acquire gold mines in Colombia, South America. It was reconstructed in 1886, and again in 1911, on the latter occasion Pellew-Harvey & Co. becoming the consulting engineers. The report for the year ended June 30 last shows that 27,855 tons of ore was sent to the mill, and that the yield of gold was 24,072 oz. In addition, 650 oz. was recovered in the tributer's plant. The income was £110,546, and the net profit £17,352. Out of this, £4,000 has been allocated to the fund for the redemption of debentures, £4,513 has been paid as debenture interest, £2,339 as preference dividend at the rate of 10%, and £9 000 as ordinary dividend at the rate of 5%. A majority of the debenture holders have agreed to extend the time of redemption for 5 years from July 1, 1921. These will be given the option of exchanging debentures into ordinary shares of the same amount. At the mine, the developments have not fully maintained the reserve, though more work was done in this direction than during the previous year, the figures being 58 500 tons averaging 18 dwt., as compared with 64,300 tons of similar content the year before. The adverse result is due to the lode being poor in places, and also to splitting. The ground has been fully prospected from the 13th level upward, and more prospecting will have to be done in depth. The results on the 14th, 15th, and 16th levels have been variable.

Tolima Mining.—This company was formed in 1871 to acquire the Frias silver mine, in the Republic of Colombia, South America. In the early days the operations were highly profitable, but in 1903 and 1909 reconstructions became necessary in order to provide funds for future developments. Since 1909 small dividends have been paid and the debentures redeemed. From October, 1915, to February, 1916, the English buyers of the concentrate were not able to smelt the concentrate owing to the Government requiring non-argentiferous lead. The report for the year ended June 30 last shows that the company has been hampered by lack of shipping, and 500 tons of concentrate still lies awaiting transport. In the meantime it has been necessary to issue £15,000 debentures in order to keep the finances of the company straight. During the period under review, the yield of concentrate was 605 tons averaging 319 oz. silver per ton and 11% lead. This was extracted from 7,462 tons raised and from the dump. The loss for the year was £3,716.

Chinese Engineering & Mining.—This company was formed in 1900 to acquire coal mines at Kaiping, in the state of Chih-li, North China, and it was reconstructed in 1912 in order to effect a working arrangement with the Lanchow company, a Chinese-owned company operating in the same district. The businesses of the two companies are now controlled by the Kailan Mining Administration. The report for the year ended June 30 last shows that the Kailan sold 2,996,668 tons of coal, and that the profit accruing to the company was £524,123. Other income amounted to £63,000, and after deducting administration expenses, the net profit was £576,555. The shareholders are receiving £150,000 as dividend, being at the rate of 15%. No less than £350,000 is being placed to the account for Excess Profits Duty. This big rise in the profits has been entirely due to the favourable exchange. Particulars of this position are given in the report of the chairman's speech to shareholders, which appears in another section of this issue.

Malayan Tin Dredging.—This company was formed in 1911 to acquire alluvial tin lands near Batu Gajah, in the Kinta district of Perak, Federated Malay States It belongs to the same group as the Tronoh, Lahat, and Sungei Besi companies. The report for the year ended June 30 shows that all four dredges were at work, and treated 3,220,300 cubic yards for a yield of 842½ tons of tin concentrate, being 0·59 lb per yard. The income was £135,903, and the net profit £66,854. The dividends absorbed £30,250, being at the rate of 25%. As the balance of profit was much higher than anything previously recorded, a large share of it will be due as Excess Profits Duty. The dredges have been kept in fairly good order, except as regards the buckets. An additional 342 acres has been acquired during the year, bringing the total area to 1,565 acres, of which 169 acres has been worked out.

Northern Nigeria (Bauchi) Tin Mines.—This company was formed in 1910 to acquire alluvial tin ground at N'Gel in Nigeria from the Anglo-Continental Mines Company. An account of the properties was given in our issue of February last. The report for the year ended June 30 last shows that 535 tons of tin concentrate was produced, as compared with 555 tons the year before, the drop being caused partly by shortness of labour and partly by the termination of work on tribute. The accounts show an income of £117,899, and a net profit of £47,309, out of which £31,570 has been paid on preference dividend at the rate of 25%, and £14,584 on the ordinary shares, being at the rate of 15%. Prospecting by bore-hole has been continued, and the reserve of tin oxide has been raised from 6,876 tons to 7,324 tons. The scheme for generating electric power at the Kwall Falls has been endorsed by the civil engineer sent out, and the erection of plant will be commenced at as early a date as possible. Interesting information was given at the meeting of shareholders, which is reported on another page.

Naraguta (Nigeria) Tin Mines.—This company was formed in 1910 to acquire alluvial tin ground at Naraguta, Northern Nigeria. Other properties have been acquired since, at Karama in the Ninkada district, at Sho near Zungeru, and at Korot. F. N. Best is chairman, C. G. Lush is consulting engineer, and F. O'D. Bourke is manager. The report for the year ended March 31 last shows that the output of tin concentrate was 517 tons, as compared with 520 tons the year before; of this total, Naraguta contributed 310 tons, Karama 75 tons, Sho 92 tons, and Korot 38 tons, as compared with 373, 58, 75, and 15 tons respectively the year before. The fall in the yield at the Naraguta property was due partly to poor ground, and partly to the necessity for rearranging the method of working. At all four areas the prospects are satisfactory. The accounts show receipts of £96,377, and a net profit of £42,034, out of which £26,250 has been paid as dividend, being at the rate of 15%. The balance, together with part of the balance brought forward from the previous year, making altogether £20,000, has been placed to reserve.

Benue (Northern Nigeria) Tin Mines.—This company was formed in 1910 to acquire alluvial tin properties in the Zaria district, Northern Nigeria. It was reconstructed in 1911 and 1915. Operations were started by bucket-dredge, but the ground proved unsuitable for this method of attack and the dredge was sold The report for the year ended July 31 last shows that 192 tons of tin concentrate was won by calabashing, selling for £44,254, and that the net profit was £17,921. Out of this, £5,000 has been placed to reserve, and £7,500 has been paid as dividend, being 2s. 6d. per 10s. share, free of income tax. J. B. Settle, lately the company's manager, has been sent out to prospect for new tin-bearing ground.

Tin Fields of Northern Nigeria.—This company was formed in 1909 by S. R. Bastard and F. N. Best to acquire alluvial tin ground in Northern Nigeria. Of the properties then acquired, the Fedderi and Jarawa are now held, and the Upper Fedderi is being worked by sluicing and calabashing. R. W. Hannam is the consulting engineer in Nigeria. The report for the year ended March 31 last shows that 132 tons of tin concentrate was won, as compared with 66 tons the year before. The income was £24,031 and the net profit £12,198. In order to strengthen the financial position of the company by writing off the expenditure in earlier years, it is not proposed to distribute any dividend for the year under review; but since the closing of the accounts it has been decided to pay an interim dividend of 5% for the current year, absorbing £3,500. Recent exploration of the Lower Fedderi area proves it to be more valuable than was supposed at first, and it has become an important asset. Mr. Hannam also writes hopefully of the the Jarawa property

Jantar Nigeria.—This company was formed in 1912 to work alluvial tin ground near Naraguta, Nigeria. H. D. Allen is manager, and Oliver Wethered, P. C. Tarbutt, and E. W. Janson are the directors. The report for the year ended September 30 shows that 166 tons of tin concentrate was won. The credits for sales and production were £37,330, and the net profit was £15,216. The dividend absorbed £9,000, being at the rate of 15%, and the balance is kept in hand against Excess Profits Duty. A substantial interest has been taken in the Kuru Syndicate, which owns a property near by, and the two properties are to be worked jointly.

South Bukeru (Nigeria) Tin.—This company was formed in 1910 to acquire alluvial tin property in Northern Nigeria. Other properties have been acquired since. S. R. Bastard is chairman, C. G. Lush is consulting engineer, and E. Bottoms is manager. The report for the two years ended June 30 last shows that 174 tons of tin concentrate was won in the first year and 112 tons in the second year. The profit was £15,805, out of which £4,000 was placed to the account for income tax and excess profits duty, £3,000 was allocated to development account, £3,000 was placed to reserve, and £2,240 was distributed as dividend, being at the rate of 5%. An interim dividend for the current year, at the same rate, has also been declared. The reason why the output was less in the second year than in the first was that during the first year an exceptionally rich patch was struck. H. F. Hueston, who recently went out as consulting engineer, has sent a cabled report speaking highly of the Kuru and Shen properties

Minna (Nigeria) Tin.—This company was formed in 1912 to acquire alluvial tin properties in Northern Nigeria, and it was reconstructed in 1914. The properties now worked are on the Rafin Gora river. C. G. Lush is chairman, and Oliver Thompson is manager, H. F. Hueston was recently appointed consulting engineer, and his report is expected shortly. The report for the year ended March 31 last shows that 78 tons of tin concentrate was won. The sales of concentrate brought an income of £10,098, and the stock of concentrate at the mine was valued at £2,450. The profit was £4,451, and a dividend of 7½%, absorbing £3,159, was distributed in June last. Two mining leases have been applied for and mining rights secured extending four miles along the Katina river.

Keffi Tin.—This company was formed in 1912 to prospect properties near Keffi, Northern Nigeria. Subsequently other properties were acquired direct from the Government. W. E. Thomas is the manager. It will be remembered that Mr. Thomas gave an account of the tin operations in the district in our issue of November last. The report for the year ended June 30 shows that the output of tin concentrate was 160 tons, which sold for £37,175. The working profit was £17,906, from which had to be deducted the adverse balance, £7,991, brought forward from the previous year. The sum of £1,000 was written off development account, and £6,250 has been distributed as dividend, being at the rate of 12½%.

RUSSO-ASIATIC CORPORATION, LIMITED.

Directors : C. J. Cater Scott (*Chairman*), Leslie Urquhart (*Managing Director*), R. Gilman Brown, T. Blair Reynolds, D. P. Mitchell. *London Manager and Secretary :* J. P. B. Webster. *Office :* Pinners Hall, London, E.C. 2. *Formed* 1912. *Capital :* £300,000.

Business : The development and finance of mining properties in Russia and Siberia ; floated the Irtysh Corporation, Limited.

The sixth ordinary annual general meeting of the Russo-Asiatic Corporation, Ltd., was held on December 16 at Winchester House, London, E.C., Mr. C. J. Cater Scott (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for 1917, said that, as their company was essentially a mining development company, he would like to make a few remarks on the development, including the searching for and discovery of mineral deposits. It was the general feeling of many investors —with some it amounted to a prejudice—that mining enterprise generally was very speculative. Up to a point this was true ; the preliminary stages of search, discovery, and development undoubtedly presented their risks, but no greater blunder could be made than to assume that these risks were in all cases the same. For instance, a sharp line must be drawn between venturing forth into unknown regions in search of mineral values and their own policy of operating in regions with which they were familiar, and where they and their associated companies had been engaged for years past in similar work. In the course of this work, carried on by their geologists and engineers, a vast fund of geological data had been collected and collated ; generalities had been formulated, tested by experience and accepted as proved or revised, associations of minerals and rocks noted and deductions made therefrom. These deductions had been put to the test by development work in the field, and their truth or falsity demonstrated. In short, they and their staff had through all these years been gaining that most difficult of assets—experience—and their whole technical organization was to-day in possession of a unique mass of data bearing on their work. It was for these reasons that they had been so successful in the last few years in segregating and separating the dross from the gold, the unreliable or doubtful prospects from those which from scientific information at their disposal were certain to give results. The Ridder property had been lying forgotten and discarded for generations when they took it in hand, and the position of the Ridder Concession to-day was the best proof of what he said. With equal truth he could cite the Ekibastus properties of the Kirgiz Company. They developed vast resources of ore in the Ridder mine, and the Irtysh undertaking had passed its initial stages as a mining venture, and was now finally established as a sound industrial enterprise. By the end of 1913 they had at the Ridder proved the existence of ore having a profit value, at the prices then ruling for metals, estimated at £7,400,000, and at the Ekibastus they had demonstrated a practically inexhaustible field of coal. Their direct interest in the properties ceased in May, 1914, when they disposed of them, the consideration being the whole of the share capital of two Russian companies known as the Ridder Mining Company and the Kirgiz Mining Company. Soon after the outbreak of war it was decided to form at once a company to provide capital to equip the properties, and the Irtysh Corporation was formed, their interest in the properties being represented by the shares of that corporation. Under the conditions then existing both here and in Russia the decision to form the Irtysh Corporation was a bold one. It must be agreed that the decision was justified to-day. A great enterprise had been built up, a competent organization of technical staffs and skilled workmen had been collected, and, notwithstanding the wave of anarchy which swept throughout the country, the Irtysh Corporation was to-day possessed of undertakings which were producing revenues and which they anticipated in the near future would be in full operation.

When the Irtysh Corporation was formed the board considered the advisability of distributing the Irtysh shares among shareholders in the Russo-Asiatic, but they decided under the conditions at that time not to act precipitately. Other courses had suggested themselves, but they felt that to follow any of them would not be in the best interests of shareholders. Their anxiety had been not to be led, owing to the obscure position arising out of the war, to make any false step which might be to their disadvantage. The lapse of time, however, had cleared the situation, and there was now no doubt as to the right course to pursue. Through the energetic action during these years of war of the Ridder and Kirgiz Companies, the shares which they held should within a reasonable time become revenue-producing. Apart from this, the mining developments and acquisitions of the Russian companies showed the properties to have a potential value much greater than they were aware of when they disposed of them and when they took the shares. Further, as stated in the report, they had received proposals looking towards the opening up of some of the mineralized areas of the Kirgiz Mining Company which gave them a favourable opportunity of resuming their activities as a development company, and if the results of this work were satisfactory they would be the indirect gainers by the increased value of their shareholding in the Irtysh Corporation, and directly by their interest in the properties under development. In view of these considerations, he was sure they would agree that, by remaining a holding company in respect of the Irtysh shares, the corporation would best maintain its present strong position. With regard to the arrangements now being made for the opening up by this corporation of the mineralized areas to which he had just referred, he would say that these were extremely interesting prospects with large possibilities. They were, as the report told, in the district of Ekibastus, and had therefore the primary advantage of accessibility and of proximity to an unlimited supply of good fuel. It must be understood that the properties were undeveloped in depth, and knowledge was confined to the results of surface work ; but they had in this case the authority of their engineers and geologists for saying the prospects were most favourable.

Mr. R. Gilman Brown seconded the resolution, which was carried unanimously.

IRTYSH CORPORATION, LIMITED.

Directors : Leslie Urquhart (*Chairman*), R. Gilman Brown, Herbert Gibson, D. P. Mitchell, T. Blair Reynolds, Lt.-Col. C. A. Reid Scott. *London Manager and Secretary :* J. P. B. Webster. *Office :* Pinners Hall, London, E.C.2. *Formed* 1914. *Capital issued :* £1,519,192 ; debentures £415,860.

Business : Operates the Ridder and Sokolni lead-zinc mines and the Ekibastus coal mine in Siberia.

The third ordinary annual general meeting of the Irtysh Corporation, Ltd., was held on December 16 at Winchester House, London, E.C., Mr. Leslie Urquhart (the Chairman) presiding.

The Chairman, in moving the adopton of the report and accounts, said : Let me begin by reminding you of the fact, not realized, perhaps, by the newer shareholders, and difficult indeed to realize by any of us, that, for the first time in the life of this corporation, we meet to-day freed from that black shadow that has for so long been over our every thought and word and deed. The corporation was formed in 1914, soon after the commencement of the war. During the first two years of its existence there has, through its means, been built up from the very foundation, in spite of such difficulties both here and in Russia as I confess one would have hesitated to face could one have foreseen them, the structure of a great industry—a structure so far completed that at the end of that period finished metals from the ores of the mines at Ridder were being produced. The third year of the corporation, 1917, is that to which the reports and accounts before you relate. March of that year is the date of the Revolution in Russia, so that for nearly ten months of it the operations suffered under constantly increasing disability, accompanying Russia's quick descent into the pit of anarchy and chaos. To my mind, the fact is highly significant that, under such conditions, the operations did not stop at any time during that year, and that it was found possible to complete and set to work an important part of the plant—namely, that for the production of lead, silver and gold—thus, with the zinc plant already in operation, completely inaugurating all branches of the metallurgical programme for the extraction of the zinc, lead, gold, silver and copper metals contained in the ores. In a word, had conditions continued normal after the Revolution, the equipment of the Ridder and Kirgiz enterprises had been placed on such a basis of production that the enterprise would have been from that time onward not only self-supporting but giving increasingly remunerative commercial results.

During my stay in Petrograd last year it had already become evident, towards the end of the summer of 1917, that the Bolshevik activities among the workers and the interference in the management of industrial concerns, with the consequent economic chaos in European Russia, were having a deleterious effect on the operations of the Kirgiz and Ridder companies in Siberia. After much anxious and careful consideration, it was agreed with our Russian colleagues and managers who had returned with Mr. Jones from the property that, until conditions became normal again, it was the safer policy to curtail all expenditure and gradually close down operations as far as possible. This policy was, naturally, not easy of fulfilment, as it brought the management into antagonism with the extremists and with the Bolshevik Workmen's Soviets. The Bolshevists, thanks to German support, in October, 1917, finally usurped all power of government in European Russia. But although the reflex influence of their anarchist government was felt throughout Siberia, they were unable to enforce their decrees until early in 1918, when, with the aid of German and Austrian prisoners of war, their Red Guards obtained control of the towns on the Trans-Siberian Railway. By February of this year, however, the policy of gradually closing down and marking time had been carried out by the management both at Ridder and Kirgiz. The attempt made by the Bolsheviks in May to work the coal mines was thus rendered abortive. Our workmen, and particularly the Kirgiz, refused to work for them, and for this reason Ridder was left alone by the Bolsheviks. In order not only to protect the properties, but to retain certain members of the staffs and the most reliable workmen, as a nucleus when the time came to restart, the mechanic shops and foundries, and the companies' railways, were kept in operation on a reduced scale, all these departments being practically self-supporting on outside orders. I am glad to say that, notwithstanding great difficulties, the management and staff were able to keep these departments working, and that, as a consequence, no thefts or damage of any kind were suffered by either the Ridder or Kirgiz properties. The Bolshevists, however, were only a few months in power in Siberia ; by the end of May of this year bands of Czecho-Slovak prisoners ot war, aggregating in all some 50,000 men, who had lost patience owing to the bad treatment they had received at the hands of the Bolshevists, joined the movement against the Bolshevist regime in Siberia. By the end of June these small but gallant bands, aided by Siberians, Cossacks, and Russians, had cleared the towns of Western Siberia of the anarchists. They then joined hands with the Russians under Semenoff and their compatriots who were fighting the Bolshevists in the Far East, and by August of this year Siberia and the whole country, from the Pacific Coast practically to the Volga, was cleared of Bolshevist domination.

The influence of this movement on the Irtysh river was felt almost immediately after it had started. The management considered the time had come to restart those departments which would be self-sustaining or give an immediate profit. While the production of coal, which was restarted in August, was necessarily small at the beginning, until the mines were cleared of water, the mine equipment overhauled, and workmen gradually returned to the property, yet the production has continuously increased, so that against some 10 tons a day which was being produced in August, by the end of October the production had reached 120 tons per day, and was steadily increasing as the Kirgiz workmen were as steadily returning to work. The production of coke was restarted in November. The local prices for coal and coke are high and the production of these departments is very remunerative. The lead plant is being put into commission again, as the price for lead shot is so high in Siberia that lead smelting will yield considerable profits. It is not proposed to operate the zinc plant at present, as under existing conditions it is considered better to wait until conditions in European Russia are stable again or until the opening of the ports permits its export abroad. At Ridder it has been decided not to put in hand for the moment the work of unwatering or of operating the Ridder mine, as this demands considerable financial outlay, while the ore from Sokolni mine is sufficient for our present purposes. Apart from the machine shops and railways, which have all along been kept in operation, the mill at Ridder has been partly adapted for the recovery of gold from the tailings dumps, supplemented with gold ore from the Sokolni mine, of which there are large quantities stocked on the surface. The river fleet is at present being overhauled preparatory for 1919 navigation, and will be used for our own and our customers' transport purposes, and should give considerable profits. In a word, the policy of the management has been to feel their way very carefully, to start those departments of work which were immediately remunerative, and to obtain the maximum possible income from the sale of the products and from transport services of the railways and fleet, delaying the larger programme of capital construction and exploitation entailing large expenditure until the directors arrive at the properties Mr. Mitchell, whom I think you all know, is now on his way out; Mr. Jones, who is with us to day, leaves early in January, and I propose to leave for Siberia about the end of January next.

During the whole of this time of chaos and trouble no remittances have been made to the properties by either Petrograd or London, but, owing to the policy of marking time and curtailing all expenditure, the funds unavailable from the sale of products or from the working of the railways have been forthcoming from the Russo-Asiatic Bank, as the companies' credit is locally very high. The deficits, however, were small, the monthly shortage at the Ridder, for instance, was only some £400, and although I have not got the figures, yet I feel sure that the operation of the properties to-day is covering all expenses and is giving quite a nice profit.

The question of labour, owing to the changed economic conditions all over the world, looms very large in the minds of all employers to-day. It is a question of the first importance, and I think you will expect me to say a few words on this subject so far as it concerns our own work. During an experience going back a long number of years in the Urals and Siberia in the development of the great mining and metallurgical industries belonging to this group of Russian companies, it has always been our earnest endeavour to provide, as far as circumstances would permit, for the comfort of our workmen and their families. To this end colonies of dwelling houses, with proper sanitary arrangements, supplied with water, fuel and light, were provided; co-operative stores and vegetable gardens supplying the population at cost price; schools, churches and clubs for the men and their families; hospitals and maternity hospitals were established. All this we have done, and done well, both at Ridder and Ekibastus. As we were starting a new industry in a new country, and although labour was comparatively cheap, we were able not only to introduce modern methods of mining, but we equipped all our mines and works with labour-saving appliances, and were thus able to pay comparatively high rates of wages. This policy not only attracted good workmen, but was the basis of that good feeling which has existed all along, and during these troublous times, between the management and the men As proof of the loyalty and trust that the workmen as a whole have in the management and future of both the Ridder and Kirgiz enterprises, notwithstanding all the anarchist influences brought to bear by the extremists and Bolsheviks, and when the economic chaos in European Russia made it impossible to remit moneys to the properties, the workmen continued to work for nearly four months without wages, asking only to be provided with food, and, above all, they refused to work for the Bolsheviks. At Ekibastus the great majority of the workmen are local Kirgiz Mussulmans, a naturally peaceful and industrious people who have never caused us any trouble. Living as they do in large numbers in the district, they look upon our enterprise as a godsend, as they have practically no other source of steady employment; they would not allow Bolshevik influence to spread, or allow any damage to be done to the works. For these reasons every effort has been made by the management, and with complete success, to train the Kirgiz, who already represent about 80% of the workers at the coal mines. This fact is very important, for, while Ridder will never require a very large number of men because of the nature of the work—probably never more than 1,000 men—the contrary is the case with the expansion of coal mining at Ekibastus. For all these reasons the question of labour is one that does not present to us any danger or difficulty either now or in the future, so long as we continue to handle it as we have done. Finally, the managing director has recently cabled to us that the spirit of the workmen continues to be quite satisfactory, guaranteeing future large scale of work at the properties.

We can now say that we have successfully weathered the terrible crisis of the Revolution and the Bolshevik regime, with its accompanying political, financial and economic chaos. That we have come through so well, that our position in every respect is so strong, is largely due to the loyal co-operation of everyone concerned, but, as is always the case, the men on the spot had to bear the brunt of the work, danger and anxiety. The managing director of the Russian companies, Mr. Feodossieff, had towards the end of last year succeeded in escaping from Petrograd, and had established himself at Omsk in order to be in close touch with both Ridder and Kirgiz. Mr. Feodossieff in the late Tzar's Government held the position of a Minister, being Director of the Credit Chancellery of the Ministry of Finance and Controller of Accounts of the Russian Empire. He is a man of the highest character, and was responsible at that time for carrying through all the financial arrangements which were made between Russia and England A young man—he is under 40 years of age—he climbed unaided and by sheer capacity to one of the highest positions in the Russian Empire. With the Revolution he, of course, lost his position and his pension; he joined our organization in Russia in April, 1917. I worked in close contact with Mr. Feodossieff at Petrograd for over five months last year, and the more I knew of him the more I was satisfied that he was the right man in the position. I think it is due to Mr. Feodossieff that I should make this statement to the shareholders, as I am proud to say that my confidence and that of my colleagues in this gentleman has been more than justified. During a time of great stress, strain, and danger, he was able, by his own personal example, and acting entirely on his own discretion, as we were unable for months to come into touch with the properties, to act wisely and well in our general interests. It is only fair that I should also mention the manager of the Ekibastus property, Mr. Radziukinas, and the manager of the Ridder property, Mr. Lessig, who supported him loyally under conditions of the greatest difficulty and danger. At the end of July of this year I managed to get through to Petrograd and Moscow, but for reasons of personal safety I was obliged to leave somewhat precipitately after only a few days in those cities. Nevertheless, my visit was useful, as it let our Russian directors and friends know that we had not forgotten them and that our sympathies were with them in their time of trouble and danger. I urged Baron Meller-Zakomelsky—a good friend of many in this room and the President of our Russian companies—together with Mr Kabanoff and Mr. Romanoff to leave for the south as they had done everything possible to protect our interests in European Russia. I am glad to say that a few days after my departure Baron Meller-Zakomelsky and all our friends got away to a place of safety. It is impossible to mention all the members of the management and staff individually, but we owe them all a deep debt of gratitude for sticking loyally to their posts and for all their efforts in our interests.

When in December of 1914 the directors of the Russo-Asiatic Corporation deliberately chose to form the Irtysh Corporation to continue to finance the development and equipment of the properties which they had sold in May, 1914, to the Ridder and Kirgiz Companies in Russia, there were many of our friends who doubted the wisdom of appealing to our group of shareholders for funds and of pressing on with construction work and of attempting to bring the properties to the profit-earning stage during the war. If anything were needed to prove that we were right in our decision and in relying on the financial support of our shareholders, the record of work done and the position and value of the business to-day is a very generous justification of our confidence and of our work. The Ridder Railway, 75 miles in length, was constructed and equipped. The Ekibastus Railway, 90 miles long, was relaid and put into running order. River transport was organized by the purchase of a large fleet of steamers and barges. While proved ore reserves are no measure or criterion of what we can confidently expect from our great mineralized concession, we nevertheless increased the proved ore reserves from 2,448,000 tons, estimated at a profit value of £7,400,000, to 3,534,000 tons estimated at a profit value of £13,000,000, and this profit is based on pre-war prices for metals. The Sokolni mine was shown to be at least as valuable and great as the Ridder; it has been shown that for all practical purposes the question of ore reserves need never trouble us, and can only be limited by our ability to handle and smelt it. The geological department has discovered on the Ridder Concession six mineralized belts containing the outcrops of a number of new deposits similar in character to the Ridder. Five of these belts are of the same type, but of much greater extent than that on which the Ridder, Sokolni, Krukovsky, and our other known mines are placed, while the sixth belt is similar in occurrence to the Kyshtim mineralized areas and contains several large gold-bearing iron gossans which have been conclusively proved to be the cappings of copper ore deposits. The equipment of the coal mines has been brought up to a productive capacity of over 150,000 tons a year, and this capacity was being rapidly increased, while our coal basin was shown to contain inexhaustible reserves of finest coal. The Ridder and Sokolni mines were developed and equipped for a large production. Power plants, machine shops, foundries, brick works, colonies of dwelling houses for the employees and workmen and their families were established. At Ridder the concentrating mill and sulphuric acid works were built and put into operation. At the collieries zinc, lead, and copper smelters, with an output capacity of 15,000 tons refined lead and 5,000 tons refined spelter per annum, with more than ample capacity for treating the accompanying precious metals, are completed and in operation. The metallurgical problems have been completely solved. In a word, this great mining and metallurgical enterprise is now established and ready to earn large profits.

The Russo-Asiatic Corporation had already expended on the properties of the Ridder and Kirgiz companies at the time of the formation of the Irtysh Corporation £284,000; since December, 1914, the Irtysh Corporation has advanced to the Russian companies and spent in and about the business £1,104,000. Credits from the Siberian Bank to the amount of over 4,000,000 roubles have also been spent on the development and equipment of the properties. When considering the expenditure made and the value of that development and equipment to-day, regard should be had to the serious decrease in monetary values all the world over, and that the expenditure to develop and equip the properties now would cost twice, nay, probably three times, what it cost us in pounds sterling when it was done. If the equipment of the properties is so much more valuable, the value of our ore reserves is, owing to the decrease in monetary values, immeasurably greater still. The shortage of production and the depletion of ore reserves owing to the increased rate of exploitation of the known metal deposits during the war, the fact that the new mines which have been discovered are not sufficient to make good the large depletion in the world's known non-ferrous metal ore reserves, and, finally, the increased cost of labour and production generally, make the future prosperity of this great enterprise certain and independent of the fluctuations which may affect producers of other commodities. By continuing without flinching, by facing the risks and responsibilities in the development of the enterprise started by the Russo-Asiatic Corporation, we are at least three years ahead of where we should have been had we chosen to delay, marking time, waiting for the peace which has taken so long to come.

We have every right to look back with pride on the work that has been done, and, speaking as a shareholder, we have every right to look forward with confidence to the future of this great enterprise which, I am sure, must become one of the key industries of the world, and of greater value to-day than it would have been, compared on the same basis, before the war. In this connection I should mention that, in order to husband our resources for the important work we have in hand, the Kirgiz Company is making arrangements with the Russo-Asiatic Corporation for the development of the mineralized areas in the vicinity of Ekibastus, mentioned in my speech of December, 1916. These contain excellent prospects of opening up into bodies of copper ore of great importance analagous to the well known porphyry copper mines of the United States, which are now responsible for more than half the copper production of America. As the holding of the Russo-Asiatic Corporation in our company amounts to, roughly, 50% of our share capital, a partnership arrangement such as we contemplate is in every way advantageous and free from complications. Our present policy is to feel our way carefully, to start those departments of work which are immediately remunerative, until gradually—and I hope this will be by next spring—the whole fabric of our undertaking will again be in full and active life. Above all, we must not launch rashly on an extended programme of construction work until economic conditions have become comparatively normal again, not only in Siberia, but in European Russia, and indeed all the world over. Our future construction programme will be a large one if we are going to do justice to and exploit, on the scale they should be exploited, our vast reserves of ore. But metal values are not depreciating, and by going carefully we shall save ourselves a vast amount of expenditure and unnecessary risk and recoup ourselves many times over for our caution.

Our financial position is sound. The business is well equipped; at the present moment all departments, with the exception of the zinc plant, are in operation and giving commercial results which more than cover expenses, while the enterprise as a whole is in a position, as soon as we are in full swing again, not only to cover expenses, but to earn large profits. There is a large working capital in stocks of materials and metal concentrates, of which we estimate the value to be at least £600,000, and the Irtysh Corporation has at its disposal in London some £175,000 in cash. Besides these funds there are outstanding 311,422 £1 shares optioned at par to the original subscribers of the debenture issue, the options expiring 1½ years after Peace has been signed. I have no doubt that these options will be duly exercised and will bring in another £311,422. Our credit is high, and deservedly so, and we have besides the advantage of an allied enterprise, the Russo-Canadian, whose shareholders are largely the same as those of this corporation, ready to assist should we desire. For all these reasons your directors are satisfied that, having financed all our requirements during most difficult times and weathered the storm, there need be no fear as to finance in the future under the more favourable conditions which are gradually rising into sight. I have tried to show that the foundations upon which the Irtysh enterprise rests have been well and securely built, that they have been preserved and even strengthened during the months of revolution and chaos in Russia, and that their rapid extension and the prosperity of the business now only depend on normal working conditions and stable government being re-established.

In Siberia and the Urals a sane Government already exists; law and order have been re-established and the rights of the person and property recognized, while economic conditions are daily becoming better. Admiral Koltchak, the head of the Siberian Government, is a good friend of mine, and I can therefore speak from personal knowledge, knowing him as a man of high character and courage, no politician, but a patriot who thinks only of the good of his country. Koltchak, as head of the Russian Fleet in the Black Sea, made good during the war; he was trusted and respected by his men, and was the popular Russian naval hero. While he has declared himself an enemy of reaction and pledged himself to independence of party, it is his firm conviction that law and order, the fundamental basis of all government, can only be re-established by military force, and supreme power must be wielded by one hand. That the directorate and all previous anti-Bolshevik Russian governments have failed is, firstly, because in Russia a democratic foundation does not exist; the people are politically undeveloped; they are ignorant and illiterate children, who have been used to be governed and led, but not consulted; and, secondly, all previous anti-Bolshevik governments have been a failure because they were subject to internal antagonistic political currents, and as such they lacked initiative, taking only half measures where decisive action against all forces of disorder was necessary. Koltchak has now the supreme power. He has the will and knows what he wants. The new vigour of his military administration is shown, not only by the conditions of Siberia, but the news that has been coming through to us lately of the defeats he is inflicting on the Bolshevist forces, only Russian troops being engaged. Koltchak's one aim at the present moment is to join hands with those other parts of Russia already freed from the Bolshevists, to co-operate in re-establishing law and order in North and Central Russia. It is a pleasure for me to be able to inform you that, after many refusals to figure in different Siberian and all Russian governments, following the overthrow of the Bolshevists, our managing director, Mr. Feodossieff, eventually agreed to assist the head of the State in financial matters and replace him as President of the new Extraordinary Economic Committee of the Siberian Government, reserving all his duties in our companies.

But while in Siberia conditions are again becoming normal, the Bolshevik reign of terror and anarchy in European Russia must continue to some extent to delay the full restoration of the economic life of the country. There can be no doubt that all over European Russia men are longing for a return to order and discipline, and would welcome any man or group or organization that was capable of restoring the fundamentals of civilized society. Here and there a reaction has already set in. The feeling of antagonism in Siberia was always very strong. The Bolshevik régime had a very short life there; the Siberians would have none of it. This reaction against Bolshevism set in many months ago in South-Eastern Russia and in the Ukraine, which seceded temporarily from North and Central Russia, and where conditions were so anarchical that the unarmed and defenceless people invited the Germans to occupy their country, for even German vassalage with its guarantee of order and security seemed preferable to Bolshevik control. To assist in the solution of the Russian problem is a duty we and our Allies cannot shirk. For the salvation of European Russia from a tyranny so merciless, so disruptive of all the sanctions and the obligations of human society that those who have lived under it would welcome anything—even German domination—that offered a way of escape. Great Britain and the Allies cannot leave European Russia to remain in the grip of murderous ruffians, a scene of wholesale massacre and loot—a great danger to civilization and the peace of the world. A start has already been made. There are Allied expeditions in the North, the Murman coast and Archangel and in Siberia. The Baltic is now free. The opening of the Dardanelles has opened a way at last to the warm water ports of the Black Sea and to the deliverance of Russia. If Bolshevism in European Russia is largely the result of the terrible economic conditions, the sufferings and discontent caused by the war, then the end of the war and the reopening of the ports signalizes the revival of trade, and this will, more quickly than anything else, resuscitate the ordered and economic life of the country. With the Allied military assistance which is and should now be freely given, I am convinced that in a short time the Bolshevik reign of terror in European Russia will be at an end. I now beg to move that the report and accounts before the meeting be received and adopted.

Mr. R. Gilman Brown seconded the motion, which was carried unanimously.

Mr. T. Blair Reynolds next moved the re-election of the retiring directors, Mr. Leslie Urquhart and Baron V. V. Meller-Zakomelsky.

Mr. C. J. Cater Scott seconded the motion, which was unanimously agreed to.

The auditors (Messrs. Deloitte Plender Griffiths and Co.) were reappointed, on the motion of Mr. Coad, seconded by Mr. Coldstream.

Mr. McLeod said he thought before the meeting closed, the shareholders would like to pass a special vote of thanks to the Russian directors in recognition of their services. He was sure they all thoroughly appreciated what the directors on this side had done on behalf of the shareholders, but, from what Mr. Urquhart had said, the directors in Russia had been placed in a very difficult position and had loyally carried out the work which they had had to do, and he felt certain they would very much appreciate an expression of the shareholders' thanks.

A Shareholder: Will you include the staff in the vote?

Mr. McLeod: Certainly, the whole of them—the directors and the staff in Russia.

The vote was passed with acclamation.

The Chairman thanked the shareholders on behalf of the Russian directors and the staff, and stated that he would be very pleased to convey the good wishes of the shareholders to them as soon as circumstances permitted, which he hoped would be very soon.

The proceedings then terminated.

KYSHTIM CORPORATION, LIMITED.

Directors: C. J. Cater Scott (*Chairman*), Leslie Urquhart (*Managing Director*), R. Gilman Brown, D. P. Mitchell, T. Blair Reynolds, David Morgan, A. J. Hugh Smith, Saveli Polak, Baron V. V. Meller-Zakomelsky. *Secretary*: J. P. B Webster. *Office*: Pinners Hall, Austin Friars, London, E C. *Formed* 1908. *Capital issued*: £1,254,240, in shares of £1; debentures outstanding £7,600.

Business: Holds the whole of the share capital of the Kyshtim Mining Works, a Russian company operating copper and other mines in the Urals.

The adjourned eighth ordinary annual general meeting of the Kyshtim Corporation, Ltd., was held on December 19, at Winchester House, London, E.C., Mr. C. J. Cater Scott (Chairman of the company) presiding.

The Chairman said: Ladies and Gentlemen,—Our first business to-day, which I hope need not detain us long, is to deal with the report and accounts of the corporation for the year 1916. I presume they may be taken as read. You may remember that our accounts were not presented at the last annual general meeting because the audited accounts of the Kyshtim Mining Works were not completed, and the general meeting of that company, at which the disposal of the profits for the year would be determined, had not been held. We deferred the completion of our own accounts in case the Kyshtim Mining Works should pass resolutions under which a credit in respect of the profits of 1916 would appear in our books. Our meeting of a year ago was therefore adjourned to await the Russian accounts. But the completion of the affairs of the Kyshtim Mining Works in respect of the year 1916 was destined to remain unsettled. Soon after our meeting the Bolshevists were pleased to "nationalize" the Kyshtim Mining Works; the books of that company were seized and its board was powerless. In these circumstances the accounts of this corporation for 1916 have been closed and merely show the London expenses set against the book entry of interest charged against the Kyshtim Mining Works, leaving a credit balance on the year of £1,538, the credit balance in the balance sheet being £82,049. We record in the report what I was able to tell you at the last meeting, namely, that the profits of the Kyshtim Mining Works for 1916 amounted to about 6,000,000 roubles, before charging either taxes or the several amounts which would have been reserved. This profit compares with 4,400,000 roubles for the previous year. These figures are now ancient history, but I should like to make one remark about them before we proceed to discuss more recent events. I wish to point out that the larger return in 1916 is not attributed to war profiteering on the part of the Kyshtim Mining Works. The scope of the operations at Kyshtim had been much enlarged by extensive additions of plant and machinery which was installed in order that all the resources of the estates might be utilized to the full in the production of war material. Considerable capital was required for these purposes, which in great part was provided from the cash resources of the Kyshtim Mining Works, so that the increased returns were by no means due to inordinate profit-taking. I should add that the Kyshtim Mining Works took all the steps it could to alleviate the hardships that must befall a civilian population in war time, and that there was little discontent among the 100,000 inhabitants of the estates, the workmen doing their best by their labour to aid their brothers at the Front in defence of the Russian Empire. This, as I have said, is ancient history, but you will agree with me that it is proper to record it before we close the page of 1916, the last year of Russia's war with her external enemies. I now beg to move that the report and accounts before you be received and adopted.

Mr. Leslie Urquhart (managing director) seconded the resolution, which was carried unanimously.

The ninth ordinary annual general meeting was then held, Mr. C. J. Cater Scott again presiding.

The Chairman said: We now come to consider the affairs of the corporation for the year 1917, as set forth in the report and accounts, which again, I presume, you would wish to be taken as read. In March of that year the Revolution, which was to overthrow all that was evil in Russia and to inaugurate an era of happiness and content, took place. The actual results of the Revolution are only too well known to us, and I will only refer to their effect on the Kyshtim Mining Works and thus on this corporation. You will readily understand that the Russian company's records and accounts, which, as I told you just now, were incomplete for 1916, are non-existent for 1917. We are without the interesting report by the consulting engineer on the operations for the year which has hitherto accompanied our report, and the books of the Russian company having been, as I have told you, seized by the Bolshevists, there was no possibility of preparing accounts. The accounts of this corporation now before you are therefore on the same lines as those of the previous year. The profit and loss account, taking into consideration interest charged against the Russian company, shows a small credit balance, making the amount to be carried forward £82,401.

There is little to say of the operations at Kyshtim during 1917. Although the officials of the Kyshtim Mining Works loyally remained in charge throughout the year, it was found that as it became constantly more difficult to maintain discipline, labour became more and more unreliable and inefficient. At the time of our meeting last year the latest reports in our hands from Kyshtim were for September of that year. Further belated reports coming to hand, the latest only reaching us at the end of March, 1918, confirmed the forecast then made that we should find costs largely increased and output falling off for the year 1917. You will have seen from the directors' report that the output of copper showed a decline of nearly 1,400 tons, and as to cost, while specific figures are lacking and we cannot give actual costs, we do know that owing to the smaller production and under the disorganization and economic conditions then existing the cost was considerably increased. It is worthy of note that, despite the state of disorganization in the district, the excellent geological staff persisted in its investigations and actually in the year of the Revolution completed their work, demonstrating, as reported to you a year ago, the existence of a definite tonnage of ore in the newly-discovered copper deposits in the northern part of the estates. This new mining district may well prove to be as important as that of the Soymanovsk Valley, in which all our operating copper mines are situated.

It may be said that a line from the Northern Urals to the Volga at Nijni Novgorod formed the eastern boundary of effective Bolshevist influence, and it is evident that great efforts were made to instil extremist principles in the industrial districts having Ekaterinburg as a centre. These efforts were not without success in poisoning the minds of some of the younger workmen and office employees at Kyshtim, but there is evidence to show that the older workmen were not in sympathy with the loud denunciations of the mining works, prompted from Bolshevik headquarters, for they knew that the great organization built up since this corporation was formed had brought nothing but prosperity and contentment to the population. There was not, however, sufficient power of resistance to prevent a decree which purported to nationalize the Kyshtim Mining Works. This decree was issued in December, 1917, and put in force in January of the present year, when some of our managers were compelled to leave. Under the control of the Workmen's Committee operations of sorts, of which, however, we have no records, continued until late May, when the surprising success of the Czecho-Slovak adventure brought their forces into our neighbourhood. In the first days of June the Czecho-Slovaks routed the Bolshevists a few miles from Kyshtim, and as a result our property was evacuated by the Red Guard and occupied by our Allies, and has been free from Bolshevist domination ever since. The first object of the Provisional Anti-Bolshevik Government which was then formed was to find employment for the local population, and the authorities of the Government, therefore, again started operations, the works being undamaged. Government control was, however, in this case, on very different lines. One of the general managers of the Kyshtim Mining Works, in whom we have the utmost confidence, was put in charge, and he was informed that as soon as a duly authorized representative could attend the property would be handed back to the company. We have not yet heard that this formality has been completed, but we may safely say that to all intents and purposes we are now in the same position as we were, so far as our title is concerned, before the Revolution. Any elaboration of this bald and brief summary that I might attempt could not hope to do justice to the difficult and exacting tasks of our staff during this period, extending even to the present. I cannot leave this part of the subject without alluding to the dangerous position in which the directors of the Russian company found themselves in Moscow, completely severed from connection with the managers at Kyshtim. Our managing director, Mr. Urquhart, was able to see many of the members of the Russian board during his adventurous trip to Moscow last summer, among them Baron Meller-Zakomelsky and Mr. Saveli Polak, both members of the board of this corporation, and it was with profound relief that we have learned of their safety, that they have been able to escape through the Bolshevist lines to places of at least comparative quiet, and that they had taken all steps possible to place in security valuable papers from the archives of the company.

Our general policy for the present is embraced in a sentence: it is to re-establish operations in those departments which can be self-supporting, and, as the situation becomes clearer and the ground firmer under our feet, to increase the extent of these operations, embracing new departments as the opportunity offers.

After such an orgy of disorder we can scarcely expect things to resume their customary regularity without some delay, but the political situation is now in our favour, and the gradual strengthening of the Government established in Siberia and the Urals now proceeding will continue, as it has done since it has come into power, to strengthen the foundations of normal economic life in the country. Authorities on Russian matters regard the present Government in Siberia as the strongest yet formed. It is proceeding on sound lines and has gained the support of experienced public men in the country, who have hitherto been reluctant to join any of the experimental administrations. Among these are men well known to ourselves and in whom our confidence is unbounded. With regard to the financial position of the Russian company our information is somewhat indefinite, but we are assured by the manager, who lately arrived in this country, that there are large stocks of copper—over 3,000 tons—together with gold and silver, lying at the works, and besides this the credit balance at the banks is between three and four million roubles. The Siberian Government has recognized its liability for damages and financial expropriation or loss caused by the Bolshevik régime, and when the proper time comes a claim will be preferred by the company for restitution of materials and funds expropriated by the Bolsheviks. In the meantime any funds required for the starting of the operations of the different departments have been supplied by the Siberian Government. We therefore do not anticipate any financial difficulty in resuming operations, as it is to the vital interest of the Siberian Government to re-establish the economic life of the country and its credit as an honest Government abroad. Regarding the general economic conditions it is not possible to say much ; there is, of course, a general lack of ordinary supplies, such as domestic utensils, agricultural implements, clothing, and boots. By the operation of our own iron industry some of these are being provided, others are coming in from abroad, either in the regular course of trade or by Allied Government assistance, which is now being freely given.

Let us now briefly consider the various activities of the Kyshtim Mining Works. Chief, of course, is the copper business, with its mines, smelters, and refineries, capable as a whole of turning out from 12,000 to 15,000 tons of copper a year, with the associated gold and silver values amounting to over £20 sterling per ton of copper. The iron business was in normal times only a secondary industry on the estates, but under present conditions has become not only an important contributor to the general revenue of the undertaking, but is assisting in supplying the immediate needs of the population of Siberia and the Urals. In order to meet the war requirements of the Russian Government, and at their request, certain standard chemical industries were established, for which Kyshtim, with its natural resources of basic materials, was peculiarly well placed. These included a sulphuric acid plant of 8,000 tons capacity per annum, a dynamite plant of 1,200 tons with its accessory nitric acid works, and a plant for the production of 4,000 tons a year of sulphate of copper. While these different works were originally intended for war purposes, they were designed and built with a view to their exploitation after the war, and represent to-day sound business undertakings capable of considerable extension. It should be mentioned that the greater part of the cost of these new and important branches of our business, entailing a large capital outlay, has been defrayed out of revenue. I think the shareholders should be congratulated that the surplus cash should have been invested in these works, and so remain fixed assets of large value instead of being squandered by the Bolsheviks.

Besides these developed features of our business, which, as the economic situation approaches the normal, assure the resumption of the profit-earning capacity of the Kyshtim Mining Works on an even higher scale than before the war, it is proper to call attention to other resources, which, as they are developed, will make for increased life of the business and expanding sources of revenue. As reported last year, further bodies of copper ore have been proved by surface work and drilling, and there is a long stretch of the mineralized belt as yet unprospected, but concerning which our geologists speak with confidence. These point to an indefinite continuation of the copper business beyond the life assured by the reserves in our operating mines. There is also the nickel, to which again reference was made last year. The 200,000 tons of ore carrying 2% nickel, which our engineers regard as assured, represents only a fraction of what we have a right to expect, as the area of untested ground on which the indications are identical is of great extent. As I review these activities and potentialities of our Russian company, and when I consider the sound foundations on which the undertaking rests, I find myself impressed by its magnitude and future possibilities. In the Kyshtim business, by the exercise of sound methods and of technical skill, there has been built up the fabric of a great industrial enterprise, giving promise of a long and successful life. I now beg to move that the report and accounts before you be received and adopted.

Mr Leslie Urquhart seconded the resolution.

In reply to a question raised by Mr. Prowse, Mr Urquhart stated that certain credit balances at the bank had been expropriated, but the company had the receipts, and when the time came their claim, he took it, would be satisfied by any stable Government which was recognized by the Allies. Unless they recognized their liabilities as an honest Government, he presumed the Allies would neither assist nor recognize them. At all events, in Siberia all the company's claims had been recognized, and they were again able to use their account at the bank. The sums which were expropriated were in Petrograd, where the company's head offices were at the time. He might also mention that they were fortunately overdrawn at the bank at Petrograd.

Mr. Coad inquired whether the company was able to sell and export the copper outside Russia.

The Chairman said that there was no difficulty about that, except perhaps as regarded rail transport at the present time.

The resolution was then put and carried unanimously.

Mr. Urquhart next proposed the re-election of Mr C. J. Cater Scott, Mr. R. Gilman Brown, and Baron V. V. Meller-Zakomelsky, the retiring directors.

Mr. T. Blair Reynolds seconded the motion, which was unanimously agreed to, and the Chairman returned thanks on behalf of himself and his colleagues

The auditors (Messrs. Deloitte, Plender, Griffiths and Co.) were reappointed on the motion of Mr. Francis Moore, seconded by Mr. Coad.

The proceedings then terminated.

TANALYK CORPORATION, LIMITED.

Directors: Leslie Urquhart (*Chairman*), R. Gilman Brown, Herbert Gibson, D. P. Mitchell, T. Blair Reynolds, Lt.-Col. C. A. Reid Scott, Baron V. V. Meller Zakomelsky. *London Manager and Secretary*: J. P. B. Webster. *Office*: Pinners Hall, Austin Friars, London, E.C. 2. *Formed* 1912. *Capital issued*: £353,991; debentures £198,357.

Business: Holds the entire share capital of the South Urals Mining & Smelting Co., a Russian company operating copper and gold mines, in the Southern Urals.

The sixth ordinary annual general meeting of the Tanalyk Corporation, Ltd., was held on December 19 at Winchester House, London, E.C., Mr. Leslie Urquhart (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for 1917, said: I presume it will be your pleasure to take as read the report and accounts which have been circulated. The corporation's accounts call for no comment from me, for they only deal with ordinary London expenditure and charges to the Russian company in respect of loans, etc. There is only one point I need refer to, that is the item standing at £84,404. 1s. 1d., loan from the Discount Bank, Petrograd. The actual loan made by the Discount Bank was Rs.800,000; the figure £84,404. 1s. 1d. was the value of the loan in pounds sterling taken at pre-war rate of exchange, and remains at this figure in the books. As the loan, however, is repayable in roubles there should be a saving or gain to the corporation at present rate of exchange of some £60,000. On the other hand, all advances made by the corporation to the South Urals Mining and Smelting Company have to be repaid in sterling. There has been no regular means of communication between European Russia and Siberia and the Urals for some months past owing to the fighting on the Volga front between the Bolshevists and the Siberian Government troops. Besides this, the conditions in Petrograd and Moscow since last year have made it impossible to present the accounts of the South Urals Mining and Smelting Company for 1917.

From the last data received, however, which cover the first three quarters of 1917, notwithstanding the disorganization and anarchy which existed, the gold mines produced 7,770 oz. of gold and 5,000 oz. of silver, in addition to which the copper mines produced during the year 700 tons of copper, containing 14,000 oz. of gold and 140,000 oz. of silver. The market value of copper and the precious metals, owing to the depreciated value of the rouble in Russia, was during the whole of the time, as it is at present, very high, gold being sold at as much as ten and twelve times its pre-war price in roubles, so that notwithstanding the increase in wages and expenses a comparatively small amount of metals had to be sold in order to provide funds for payment of expenses at the mines and smelters. As you know, this corporation has an arrangement with the Kyshtim Mining Works for the custom refining of copper and the extraction of the precious metals. The latest information received from the directors of the Russian company, and confirmed by the manager of the Kyshtim Company, lately in this country, was that the South Urals Mining and Smelting Company had 19,775 oz. of gold and 113,000 oz. of silver deposited at the bank at Ekaterinburg in the Urals. Considerable quantities of copper, gold, and silver in process of refinement at Kyshtim and certain stocks of unsold copper, which we are reliably informed were not expropriated by the Bolsheviks when they were in control in the North Urals, still remain at the disposal of the Russian company when matters are all adjusted.

It is difficult to estimate what the value of these stocks comes to, as we have no exact figures except with reference to the gold and silver deposits at the bank. These alone, however, come to over £100,000, and it is very probable that the remaining stocks at the refinery will add another 50% to this total. Besides the values just mentioned, the President of the Russian company—our good friend Baron Meller-Zakomelsky—and the managing director, Mr. Kabanoff, informed me in Moscow at the end of July of this year that they succeeded in withdrawing over one million roubles out of our cash balances at the banks in Petrograd a few days before these were nationalized or expropriated by the Bolsheviks, and this money is now fortunately secreted in a place of safety. A certain amount of cash at the banks was, of course, expropriated by the Bolsheviks, but we have every right to expect, when stable government is re-established, the refund of this money, together with any other confiscations made in the Urals. While this is all I can say at the present moment of the financial status of the Russian company, you will agree that, taking everything into consideration, the statement shows that the financial position of the South Urals Mining and Smelting Company is very satisfactory indeed. That such large balances were in hand, notwithstanding the anarchy and economic chaos into which Russia has been plunged by the Bolsheviks, speaks well for the ability of our mines and works to produce values, and is a very good index of their worth and future possibilities.

At our meeting last year you were informed that sulphide ore had been cut on the second level of the Tuba mine, and that development on this had shown a length of 175 ft. over 8 ft. wide, assaying 17% copper and one-fifth of an ounce gold per ton. This development has continued favourable, our last report showing a length on the 210 ft. level of 320 ft., with an average width of 12·3 ft. carrying 19·4% copper, one-fifth of an ounce in gold and 2 oz. silver. The proved reserves at this mine are now estimated at 32,000 tons of oxidized ore, averaging 1% copper, 3·3 oz. gold and 26 oz. silver, and 44,000 tons of sulphide ore averaging 14·7% copper, 0·17 oz. gold, and 1·5 oz. silver. At the Sebaeva sulphide copper mine the ore reserves were stated in Mr. Gilman Brown's report last year at June 1, 1917, as 450,000 tons, with an average content of 2·2% copper, 0·6 oz. gold, and 1 oz. silver, the proved length of the ore-body being 700 ft. and the depth 151 ft. Developments at Sebaeva have since then continued favourable; the proved over-all length, according to our last reports, had increased to 970 ft., with a depth of 151 ft., so that in the case of Sebaeva we have added roughly 40% to our proved ore reserves, bringing them up on this basis to a total of 630,000 tons. This does not eliminate the probability of considerable further extensions in length and in depth. It will be seen, therefore, that from the standpoint of a mining enterprise in the all-important question of ore reserves, our position is very sound and stronger to-day than was the very satisfactory position shown in the consulting engineer's report of last year. We are, however, allowing the old estimates to stand in our records until it may be possible for our engineers to visit the property and make a complete survey of all the mines and a new estimate which will include the good developments above mentioned.

When I last had the pleasure of addressing you I mentioned that we had tackled during 1916-1917 the question of fuel supply, on which depends the further increase of our metals production. We had then surveyed and started the earthwork and grading of a light railway, 40 miles long, to our forest concession. A large part of the earthwork, grading and bridges has been finished and the rails delivered some time ago, and while we are not fully informed as to what progress has been made lately towards completion of the line, we received a cable from the manager recently stating that at one of the stations on the line they have 55,000 cords of wood ready for delivery, which indicates a very sound position from a point of fuel supply as well as transport. The cost of the railway, which was estimated at Rs.700,000, is being defrayed entirely out of revenue. The completion of the railway will leave very little to be done for the full equipment of your property as a self-contained going concern. The question of transportation of fuel, which has always limited and hampered our operations, will make it possible to deal with the large resources of copper, gold, and silver in a more economical and profitable manner and on a larger scale than was possible heretofore.

It may be asked how is it that through all the terrible dislocations of the past eighteen months—a society overthrown, a Government scrapped, the towns of European Russia given over to famine, brigandage, and anarchy—how is it that the property remained in possession of the rightful owners and management, and that it was possible, even on a reduced scale, to continue working? I gave the reasons in my last year's speech, and they still hold good to-day. Briefly, the properties are 1,500 miles away from the centres of anarchy, Petrograd and Moscow, in a district where food is produced and is abundant, and in the country of the Bashkirs and Orenburg Cossacks, who are a stable element, as they are possessors of the lands on which they have their homes, and therefore supported each other against Bolshevik aggression. The Tanalyk properties are held on a 76 years' lease on a royalty basis from the Bashkir Mussulman communities of the province of Orenburg. Being far away from industrial centres, they lived a hard existence, and only on the advent of our enterprise at Tanalyk did they feel for the first time some material prosperity. The mining and smelting operations of the South Urals Company gave them good wages, and they were not obliged to go hundreds of miles from home in search of work. Besides giving employment, the Bashkirs were in a sense partners in the enterprise, as the royalty the Russian company pays brings in a comfortable income to the communities, which went not only towards the payment of taxes, but could be used for the more pressing communal needs. As possessors of the soil, their material prosperity was therefore bound up with the fortunes of the enterprise, and every Bashkir who wants to remain at home has a personal concern in its continued operations. They had also sense enough to see that it requires brains, technical knowledge, and expert organization successfully to operate a highly complex mining and metallurgical business, and they therefore made no senseless effort to ruin it themselves. They were not affected by the mad ideals of the Bolshevists, who were trying to establish the dictatorship of the ignorant and the brainless. Their clanship or patriarchal family life makes them disciplined and ready to respect and recognize that authority that knowledge always brings.

When the Bolshevik Government at Moscow decreed the nationalization or expropriation of all industries in favour of the proletariat, attempts were made by Bolshevik delegates to influence the 200 Russians among the workmen, with the result that the younger and more impulsive elements among these men created some trouble, and the management had to contend with a great deal of disorganization. The Bashkirs refused to deal with the Bolshevik emissaries, and from motives of loyalty, as well as in their own interests, protected the works and employees of the company against mob violence which at times threatened them. In March, thanks to the support and protection of the Bashkirs, the properties were gradually cleared of extremists. The position to-day is still more secure, as some months ago representatives of the temporary Government of the Bashkir community lands centred at Orenburg took up their residence at Tanalyk, and their attitude towards the manager, Mr. Sabunin, and the staff has been in every sense helpful, friendly, and correct. While conditions at the property have been for some time past such as to permit of working practically all departments, the economic chaos in European Russia must continue to affect the question of vital supplies, such as quicksilver and cyanide for the gold mills, coke for the copper smelters and other materials, either unobtainable at present or, if to be had, only in very limited amounts at very high prices. Until conditions become normal again in European Russia, and while the Bolsheviks continue to fight the Siberian Government on the Volga front, the major part of these supplies have to be transported from England by the roundabout route to Vladivostock, some 14,000 miles by sea and some 4,000 miles by rail, instead of some 3,000 miles by direct route as previously.

Under these conditions, we consider it is the safest policy to concentrate on construction of the railway, in preparation of wood fuel and timber at the forest concession, and generally to prepare for the resumption of operations in all departments on a larger scale than heretofore in the near future so soon as general conditions make it advisable to do so. The Tuba gold mine and mill are being operated on a reduced scale, the production of some 700 to 800 oz. of gold per month being ample to pay for all running expenses and to pay for the 650 men employed on all work in hand. We have sufficient essential stocks in hand to feel sure that we can continue on this basis for a year or more if necessary I think this survey of the affairs of the South Urals Mining Company shows an extremely strong position, not only with reference to the question of finance, but that of the all-important question of ore reserves, of equipment, and of capacity to earn large profits. The Russian company has gold and silver deposits at the bank, which can be looked upon as cash resources, valued at £100,000, and another £50,000 at least at the Kyshtim refinery, making a total of £150,000 liquid cash assets, apart from large values locked up in stocks of copper and the accompanying precious metals, a considerable working capital in stocks of essential materials and fuel at the mines, over one million roubles cash in safe keeping in the custody of the Russian directors and we have further increased the value of the property by paying the greater part of the cost—namely, 700,000 roubles—of the railway out of working expenses.

The figures of development of further ore reserves, to which I have already alluded, may not look perhaps important, but to give you some idea of what this increase in our proved ore reserves signifies, a rough estimate indicates a recoverable value, taking copper at £100 per ton, gold and silver at standard rates, of over £1,000,000, against which working costs have to be charged. We have always in the past been limited in our output of metals by difficulties of transporting fuel from our forest concession. With the construction of the railway, this difficulty will be overcome, and there is no reason why the capacity of the plant should not be at least doubled and the profits from the enterprise consequently very largely increased on a greater ratio than the increase in the capacity of the plant This position, you will agree with me, is extremely satisfactory and promises in the very near future to give us immediate and very large profits. Finally, I wish to express on behalf of the directors—and I am sure that you will join me in this—our deep appreciation of the loyalty of the directors in Russia, the management, staff, and employees in their unselfish efforts in the interests of the company during these strenuous and dangerous times. The review of the work done and the position of the company which I have tried to describe is only a small measure of their work, and I feel that we all owe them a deep debt of gratitude.

I have a certainty of conviction that the time is very near when Russia will again arise a great and powerful nation. The signs of reaction are very evident to those who know and understand the country and the people, and if only the Allies will continue to give a helping hand, and give it a little more freely than they are giving it now, the re-entry of European Russia in the comity of civilized nations will come all the more quickly. In practically all yesterday's daily papers there was a report from Moscow, evidently of Bolshevik origin, that a Bolshevik army of 1,000,000 men was already in existence, highly disciplined and well equipped, and that by the spring this disciplined army would be increased to 3,000,000 men. How any responsible newspaper can lend itself to give publicity to such scaremongering rumours without comment I cannot imagine. The imprint of their authority has led even intelligent people to accept these views without question and to credit these wild statements as facts. While I do not wish in any way to belittle the numbers or the danger to civilization of the Bolshevik army, I have it on the highest authority that the total does not exceed 700,000 to 800,000 men. The army is kept together with the greatest difficulty and only obtains recruits from among famished men. The private soldiers are paid 500 roubles a month and are given 2 lb. of bread a day, half of which they sell at 25 roubles a lb. Discipline is enforced by terrorism, a company of 100 to 150 Chinamen being attached to each regiment to act as executioners. When I was in Russia at the end of this summer I saw this wonderfully disciplined army, formed of Chinamen, Letts, Austrian and German prisoners of war, Russian criminals and men who have joined either to escape death or hunger, bedraggled and unkempt, walking in any sort of formation, their officers from among themselves. How in a couple of months this army, which was largely dependent on foreign hirelings, should have suddenly become highly disciplined and equipped passes my comprehension. The industries of European Russia in that part of the country dominated by the Bolsheviks are absolutely at a standstill; there is no production of munitions, no food or provisioning possible, except when taken by force from the peasant and accompanied with murder. Only a few days ago these same newspapers reported the attack made by these disciplined troops on Reval. These guerilla bands, accompanied by their women and children and their loot, with deserters from the German army, straggling along narrow lanes and bye-roads were repulsed by a hundred disciplined German soldiers, who drove 7,000 in front of them like sheep. The recent defeats reported in the papers during the last few days inflicted upon them by Admiral Koltchak in the Urals and the Don Cossacks in the South are of themselves sufficient evidence of the inaccuracy of the reports emanating from Moscow. To my mind, these are circulated for the purpose of intimidating Allied public opinion into a policy of forgetting their moral obligations and of refusing their assistance in the regeneration of European Russia. How thoughtless and dangerous such irresponsible scaremongering is is evident when we review the recent history of Bolshevist power; a few months ago it was coterminous with the boundaries of the Russian Empire, and to-day we see it hemmed in by Siberia and the Urals, by the Ukraine and the Don Cossack country. Allied influence for law and order predominates in the Caucasus, Central Asia, the Northern territories; Poland and the Baltic Provinces have repudiated and have separated themselves from them. The area under their control, it is true, is important, and was the former seat of Government and heart of the country, but it covers roughly some 500,000 to 600,000 square miles out of 8,600,000 which go to make up Russia, or in other words one-fifth of European Russia and only one-seventeenth of the whole. The process has been gradual, but signs are not wanting that a healthy reaction is taking place, or evidence of the position of this group of companies which are all working in Siberia and the Urals shows. With the opening of the ports, the Black Sea and the Baltic, apart from Archangel and Murman and the Far East, the influence of civilization and trade must make itself felt before very long. I now beg to move that the report and accounts before you be received and adopted.

Mr. R. Gilman Brown seconded the resolution, which was carried unanimously.

The Chairman next moved the re-election of Mr. T. Blair Reynolds and Lieut.-Colonel C. A. Reid Scott, D.S.O., as directors of the corporation.

Mr. Gibson seconded the motion, which was unanimously agreed to.

The auditors (Messrs. Deloitte, Plender, Griffiths and Co) were reappointed on the motion of Mr. Scott, seconded by Mr. Grace.

Mr. Francis Moore proposed a hearty vote of thanks to the Chairman, the directors and the staff in Russia, and the motion was carried by acclamation.

The Chairman briefly acknowledged the compliment, and the proceedings terminated.

ASHANTI GOLDFIELDS CORPORATION, LIMITED.

Directors: Earl of Bessborough (*Chairman*), Jeremiah Colman, C. W. Mann, G. Lawson Johnston. *Consulting Engineer:* W. R. Feldtmann. *Secretary:* Horace Morgan. *Office:* 6, Southampton Street, Holborn, London, W.C.1. *Formed* 1897. *Capital issued:* £220,611, in shares of 4s. each.

Business: Operates gold mines at Obuasi, West Africa.

REPORT OF THE DIRECTORS.

The directors herewith submit the statement of accounts for the financial year ended June 30, 1918. The issued share capital remains at 1,103,057 shares of 4s. each, fully paid up, or £220,611. 8s. 0d., out of a total authorized capital of £250,000. The income from all sources was £472,943. 9s. 10d.; the working costs in West Africa, general expenses and other charges in London amounted to £230,677. 2s. 5d.; showing a working profit of £242,266. 7s. 5d. From which has been deducted: cost of mines development £38,135. 4s. 11d.; Government royalty £23,205 1s. 11d.; amounts written off main shafts and for depreciation of plant, machinery, &c. £21,305. 1s. 3d.; total £82,645. 8s. 1d.; leaving a net profit for the year of £159,620. 19s. 4d. (the total of the monthly estimates of net profit, as published, was £159,431). This amount, added to the balance brought forward from last year, gives an available total at the credit of profit and loss account of £259,899. 7s. 0d. Three dividends amounting to 70%, or £154,427. 19s. 7d., were paid during the year, leaving a credit balance of £105,471. 7s. 5d. to be carried forward to the current financial year. The total ore treated was 105,452 tons, for a recovery of 108,390 oz. of fine gold, averaging 20·56 dwt. per ton, and 7,630 oz. of silver; in addition, 662 oz. of fine gold were recovered from sundry sources.

In accordance with the Articles of the Association, Mr. Charles W. Mann, one of your directors, retires and, being eligible, offers himself for re-election. The auditors, Messrs. Turquand, Youngs & Co., retire, and offer themselves for re-election.

By Order of the Board,

HORACE MORGAN,

Secretary.

London, December 4, 1918

EXTRACTS FROM THE REPORT OF THE CONSULTING ENGINEER, MR. W. R. FELDTMANN, AS AT SEPTEMBER 30, 1918.

The high cost of stores of all kinds, and, still more, the possibility of a break in the supply of some of them, had, at the time of the previous annual report, led to the closing down of the Cote d'Or mill and consequently to the postponement of the treatment of Justice's sulphide ore and of the low-grade oxidized ore at Big Blow. A further step, in a precautionary policy of concentrating all work on the most profitable sources of gold supply, was the shutting down of Ayeinm mine in February, 1918. At the existing high and increasing cost of material the £4,000 or so of gross monthly output from Ayeinm represented only a small and uncertain profit and it appeared unwise to continue consuming stores in working such low-grade ore, at the risk of running short of them for dealing with the highly profitable ore from Ashanti mine. The suspension of shaft-sinking in Ashanti mine was another war-time economy, indicated by the needs of the position and justified by the large existing ore reserve, plus the prospects of maintaining the amount of such reserve by lateral development only.

From Ashanti mine 87,498 tons of ore, treated at the Central treatment plant, yielded gold to the value of £432,800, including slags realized at home. Practically all the tonnage was extracted from Obuasi shoot, only a few hundred tons being derived from the old workings on Ashanti reef north-east. Development work for the twelvemonth amounted to 5,881 ft. as compared with 6,534 ft. in the previous corresponding period. The reduced development footage includes an increasing proportion of driving and cross-cutting carried out for the purpose of obtaining material for stope-filling. With regard to the tendency noted at No. 17 level for the Obuasi shoot at its south-west end to assume some of the characteristics of the main Ashanti reef, nothing can usefully be added to the observations recorded in last year's report, as No. 18 level has not yet advanced to the junction of the two fissures. The collective effect of new developments on Obuasi shoot and of an extension of comparatively high-grade ore disclosed in the south-west stopes at No. 4 level is that, in spite of the suspension of shaft-sinking and notwithstanding retarded development generally, the ore reserve position is, for all practical purposes, the same as last year. The actual comparison in round figures is: September, 1917: 419,000 tons, 28·4 dwt., £2,524,000 gross value; September, 1918: 411,200 tons, 28·5 dwt., £2,487,000 gross value

In January, 1918, a more than usually extensive series of falls of ground in Obuasi stopes—chiefly at Nos. 12 and 13 levels—unfortunately interfered with the regular work of ore extraction and caused a temporary drop in output for January and February. The immediate trouble was quickly overcome and the bad ground secured afresh.

At the Central treatment plant, from 99,341 tons of ore treated, gold was recovered to the value of £451,891 or at the rate of 90·97s. per ton, exclusive of slags, of a gross value of £2,709, shipped to England in February, and a further stock in hand at end September valued at £1,117. The mean residue value was 6·44s. per ton on the basis of raw ore weight, showing an extraction of 93·4% as compared with 93·5% in the previous twelvemonth.

The working costs for the twelvemonth were 54s. 4·8d. per ton of ore crushed. This covers mining, treatment, development, London office and royalty accounts. The corresponding figure for the previous twelvemonth, which included 1s. 3·6d. in respect of shaft sinking (since suspended), was 49s. 2·9d.

Repair and maintenance work has been kept up as well as circumstances would permit and, on the whole, the equipment is in fair condition. Parts of the plant, not of immediate importance, have not been allowed to encroach on supplies of material but have been robbed to some extent to make up deficiencies elsewhere.

TAQUAH MINING & EXPLORATION CO., LTD.

Directors: T. F. Dalglish *(Chairman)*, Mark Attenborough, J. F. D. Bowden, F. H. Hamilton, Sir James S. Hay, Sir Westby B. Perceval. *Secretary:* T. J. Foster. *Office:* 461, Salisbury House, London, E.C.2. *Formed* 1900. *Capital issued* £349,979 in £1 shares.

Business: Operates a gold mine in West Africa; holds shares in the Abosso Company.

The eighteenth ordinary general meeting of the Taquah Mining and Exploration Company, Ltd., was held on December 16 at River Plate House, London, E.C., Mr. T. F. Dalglish (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said that during the year 63,883 tons of ore was crushed, from which was recovered gold to the value of £180,785, equal to 55s. 9d. per ton treated. The recovery was 98% of the gold contents, which was very satisfactory. On the other side, the costs, including development redemption and London expenses, amounted to £119,830. This gave an average of 36s. 11d. per ton crushed, as against 36s. 10d. in the previous year. They then had to report an increase of 2s. 7d. per ton on the costs of the year 1916. This year the increase was only seven-tenths of a penny per ton (less than ¾d. per ton), which when the greatly increased cost of everything used at the mine was taken into consideration, was a surprising result, and reflected credit on the executive staff both on the Coast and at home. The working profit amounted to £62,322. After providing for depreciation and other sundry items, a balance remained of £43,320, which had been carried to appropriation account. Adding the balance brought forward from the previous year, there was a total credit of £70,382, from which had been paid two dividends amounting together to 2s. 6d. per share, or 12½% on the capital issued. These dividends absorbed £48,434. The board recommended that the balance of £21,948 be carried forward to the current year. As announced in the report, they were paying on December 21 an interim dividend for the present financial year of 1s. per share.

With regard to the balance sheet, the items on the debit side were all normal and called for no comment. On the credit side the expenditure on shafts and mine development showed an increase together of just over £10,000. The value of this expenditure was not yet reflected in the ore reserves, as much of the ground now being opened up was not sufficiently exposed. This was particularly so in that section of the new zone to the south above No. 9 level, where the duplication and triplication of reef occurred. Here lack of ventilation delayed the work. This had now been overcome by sinking a winze from the old No. 4 level to the No. 9. This winze had disclosed reef for a distance of 288 ft. assaying 55s. 6d. per ton over 45 in. In No. 13 level they had now opened on the new zone for some 200 ft., and were still continuing the drive to the south. The values showed an average of 57s. 9d. over 40 in. They were also sinking a winze below this level. In the main section of the mine the deepest point was 360 ft. below No. 13 level, and here, as stated in the report, they were opening out ore of satisfactory value. The stock of stores and materials showed an increase of £11,300. Now that the war was over, the necessity of maintaining such a large stock no longer existed. A considerable reduction in this item might be expected during the current year. They had added to the War Loan by investing the dividend received on their former holding.

Labour had been a difficult problem during the year, and still continued to be so. The attraction for the native of work in the cocoa industry, which was much more congenial to him than work in a mine, was an ever-growing menace to their labour supply. They did all they could to counteract this and to encourage the native to work for them by providing him with comfortable living quarters and other inducements which might add to his contentment. But still they were always short of their requirements. One of their most serious competitors was the Government, which was extending its programme of road making to assist the cocoa industry, and in other ways attracted labour from the mines. They had in the past, and still continued, to make representations to the authorities on the subject, but the position was in no way ameliorated. They hoped that some arrangement could be made to obtain labour from some of the adjoining countries, as that in the colony seemed to be already fully occupied. They had also had to contend recently with an epidemic of influenza, which had been severely felt by the native population, and practically stopped work for some time. The latest accounts showed that it had now exhausted itself, and the health of the colony again seemed to be normal.

When he met them last year he informed them that they had lodged an appeal against assessment for excess profits tax with the referees. This appeal had now been adjudicated upon, and he was glad to say the datum line of profit had been fixed at 22½%, a figure which freed them entirely from liability.

The ore reserves represented about 3¼ years' supply to the mill at the present rate of crushing, and the gold contents were estimated at a value of over £600,000. On the basis of last year's working, the divisible profit in sight was about £143,000. If their supplies and materials became less costly this profit might be exceeded. He again desired to record the appreciation by the board of the splendid work of the staff, both on the Coast and at home, during the year. To Mr. Campion was due the credit of conducting the operations at the mine so successfully, in spite of war conditions. He had worked with great economy, and they still held the creditable position of conducting their operations with the smallest staff of white men, relative to its size, of any mine on the Coast.

Mr. F. H. Hamilton seconded the motion, which was carried unanimously.

On the motion of the Chairman, seconded by Sir James S. Hay, the retiring directors (Mr. J. F. D. Bowden and Mr. F. H. Hamilton) were unanimously re-elected. The Chairman explained that Mr. Bowden was unfortunately detained on military duties in France, and had asked the shareholders to excuse his absence from the meeting.

The auditors (Messrs. Cooper Brothers and Co.) having been re-appointed, on the motion of Mr. L. R. Davis, seconded by Mr. W. Hoeltzer, the proceedings terminated.

ABOSSO GOLD MINING COMPANY, LIMITED.

Directors : T. F. Dalglish (*Chairman*), Mark Attenborough, D. H. Bayldon, F. H. Hamilton, Sir James S. Hay, Sir Westby B. Perceval. *Secretary :* T. J Foster *Office :* 401, Salisbury House, London, E C.2
Formed 1901. *Capital :* £400,000 in shares of £1.
Business : Operates a gold mine in West Africa.

The eighteenth ordinary general meeting of the Abosso Gold Mining Company, Ltd., was held on December 16 at River Plate House, London, E.C., Mr. T. F. Dalglish (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said that the board much regretted that the year's operations had not been more successful. It had been a year for the most part devoted to the reorganization of the plant under very difficult conditions. It was only now at this date that they were able to say that the power plant, the chief source of the trouble, was working satisfactorily. The smaller steam engine, to which reference was made last year, duly reached the mine and was in commission. Much material required in changing over from gas power to steam power had to be obtained locally and adapted in their workshops on the Coast. In this work they had received great assistance from Mr. Marshall, mechanical engineer of the Taquah mine. It had been a very difficult job with the material available, but it was impossible, owing to war conditions, to send the material required from this country.

The profit and loss account showed that the total value of the gold recovered during the year amounted to £154,812, a fall of about £16,000 as compared with the previous year. This was explained by the fact that the tonnage treated was only 102,256 tons, as against 112,460 tons in the previous year, a decrease of about 10,000 tons. The recovery per ton was about the same during the two years, namely, 29s. 9d. The inadequacy in their power plant again prevented stoping a full proportion of ore from the lower levels and from the West reef, which contained the richer ores in the mine. This referred particularly to the West Reef, from which was stoped 33% of the ore milled, although 50% would have been nearer the mark. This condition of affairs would they hoped be remedied. The working costs had risen 2s. 11d. per ton, owing mainly to the increased cost of all stores and materials. The net result was a loss of £1,795 on the year's working. The displacement of the gas power plant had necessitated a somewhat drastic treatment in re-valuing the plant and machinery. The value of a plant in operation was one thing, but if it had to be supplanted by another and thrown out of commission the depreciation was very great. The directors had decided to deal with this matter once and for all. They had, therefore, taken advantage of the large balance at the credit of premium reserve and profit and loss accounts and written off from them £48,785. The figures in the balance sheet were now more in accord with the actual position of affairs. The capital of £400,000 was now represented as to £380,000 by property, machinery, and plant, houses, etc., railway and rolling stock, shafts and mine development accounts, leaving £20,000, which with the balance at the credit of profit and loss account of £24,000, together £44,000, was represented by stores account and sundry debtors. The liabilities were covered by the gold and cash in hand, amounting to £18,308.

With regard to the mine since they commenced crushing in 1905 they had had to meet a continuous falling off in values until the year under review. The values of the ore reserves in 1905 were about 92s. per ton, and they declined steadily until 1917, when they were only 32s. 6d. He was glad to say the figure for 1918 showed an improvement of 9d. per ton. This was explained by the higher values in the West Reef. The reserves at June last, amounting to 280,330 tons, were made up of 134,870 tons in the Main Reef section valued at 30s. per ton, and 145,460 tons in the West Reef section valued at 36s. per ton. Although there was still an amount of ore to be opened up in the Main Reef section, their hopes were centred in the West Reef, which showed improving values. The ore exposed during the current financial year again showed an increase over the general average value of the reserves at June last. To meet the decline in the value of the ore, they had concentrated their efforts during past years on improving the extraction of gold and on reducing expenses, particularly the more expensive item of European labour. This had been a gradual process. Since 1913 they had improved the extraction by 1s. 3½d. per ton. The tailing in that year contained gold to the value of 2s. 9½d. ; it now contained gold to the value of only 1s. 6d. per ton. On the tonnage crushed last year this was equal to a saving of £6,800. During the same period they had been able by improved appliances and organization to reduce the number of the European staff from 63 to 38, representing a saving of about £15,000 per annum. These two items, amounting together to £21,800, compensated to the extent of 4s. per ton for the reduction in value of the ore treated, sufficient to pay a dividend of 5%. Had the other items of expenditure remained at their former level, they would have continued to pay dividends, but in this period stores and materials had alone gone up 5s. 5d. per ton of ore treated. On their last year's output this represented an increase in costs of £28,000.

Having regard to the conditions obtaining in the Gold Coast Colony the mine must be classed as low grade. Unless something was done by the Government to ameliorate the conditions, it was difficult to see how they and other mines of the same class were to pay reasonable dividends. They had nearly half a million's worth of gold in sight in the reserves without reckoning upon future development. It was unreasonable that they should be expected to go to the trouble and expense of producing this gold merely to hand it over to the Government without any benefit to shareholders. This question was now being inquired into by a committee of experts, and they must trust that some relief would soon be forthcoming. He desired to acknowledge the whole-hearted services rendered under strenuous circumstances by Mr. Jobling and his staff at the mine. Also the valuable assistance they had received from Mr. Campion, of the Taquah Company. Their secretary, Mr. Foster, and the London staff also deserved well of them. The Government regulations controlling the purchase and shipment of supplies had in no way relaxed and with a reduced staff had not been easy to comply with.

Mr. Mark Attenborough seconded the motion, which was carried unanimously.

NORTHERN NIGERIA (BAUCHI) TIN MINES, LIMITED.

Directors: Hetherington White (*Chairman*), A. R. Canning, G. Temple Harris, Oliver Wethered. *Secretary*: E. Price. *Office*: 19, St. Swithin's Lane, London, E.C. 4. *Formed* 1910. *Capital issued*: £97,226. 10s in ordinary shares, and £126,281 in preference shares, both of 10s. each

***Business*:** Operates alluvial tin ground in Northern Nigeria.

The ordinary general meeting of the Northern Nigeria (Bauchi) Tin Mines, Ltd., was held at the London Chamber of Commerce, Oxford Court, Cannon Street, London, E.C., on December 18, Mr. Hetherington White (the chairman of the Company) presiding.

Mr. E. Price (Secretary) read the notice convening the meeting and the report of the auditors upon the accounts.

The directors' report and statement of accounts being taken as read,

The Chairman said: Gentlemen, before I start with the business I should like to say how deeply we regret the death of our late colleague, Mr. Godfray, who was at this table with us last year. Major Canning has been elected to fill the vacancy on the board, and I shall ask you later to confirm his re-election

The report and accounts have been in your hands for some days, and at the outset I should like to be allowed to congratulate the shareholders on the excellent results achieved, enabling us to recommend the payment of a substantial final dividend for the financial year ended June 30, 1918, namely, 12½%, less tax, on both the preference and ordinary shares, making 25% on the preference and 15% on the ordinary shares for the year. I think you will agree with me that this is entirely satisfactory. Before dealing with the present position and the future prospects, I will, as I usually do, make a few observations on the accounts. On the debit side of the balance sheet you will see that the issued capital remains the same, namely, £223,508. The amount standing to creditors and credit balances is rather high, namely, £21,423. In this figure are included some heavy items for income tax, insurance, royalty, freight and charges on tin shipments. Most of these have been settled since the date of the accounts. On the credit side, the property account remains the same. On development and prospecting we added to the account £1,518, and have written off £3,521, as recommended by the manager, leaving on this account £17,744. We spent £1,574 for the year on buildings, machinery and plant, and have written off depreciation amounting to £4,180. This also was recommended by the manager. Tools and stores are taken at valuation and amount to £5,966. Then you will see that we have £40,000 invested in 5% War Loan, which we still hold. Debtors and debit balances, which, in the previous accounts stood at £20,245, were reduced, at June 30 last, to £1,490. At the date of the accounts we had a stock of tin in hand valued at £33,726. This figure represents the price since realized for the tin, with the exception of about 29 tons, which was taken at a fair valuation.

Turning to the profit and loss account, I am sure none of you will be surprised to see that all the items of expenses have increased in these abnormal times, when you bear in mind that the cost of all commodities has advanced considerably. The expenses, calculated on the tonnage recovered, namely, 535 tons for the 12 months, work out as follows: Mining expenses £70. 2s. 11d., against £58. 15s. 9d. the previous year; freight and other charges on tin £26. 0s. 6d., against £23. 2s. the previous year. I am pleased to say that we have received advice that freight on goods shipped from and to Nigeria is now reduced by 25%. Royalty on tin comes to £15. 0s. 11d. per ton, against £10. 13s. 3d. for last year. This item, of course, fluctuates with the price of tin. Sundry expenditure, which amounts to £2,951, works out at £5. 10s. 4d. per ton, as against £4 3s. 11d. last year. The depreciation of machinery, plant and buildings written off is £7. 16s. 3d. per ton, and the amount written off development and prospecting expenses represents £6. 11s. 8d. per ton. The tin sold and that in stock at the date of the accounts works out at an average of £220. 7s. 5d. per ton. The sundry receipts for interest and transfer fees amount to £2. 3s. 5d. per ton, and the profit comes to £88. 8s. 3d. per ton.

As regards the prospects for the current year, one very vital thing is the price of tin. I think, at the present moment, there is no man who would venture to prophesy what will happen in this respect. During the war, undoubtedly, there was not enough to go round for what I may call war purposes, as well as for the ordinary consumers. These latter had to go short always of what they asked for. It is very unlikely, I think, that there will be any considerable drop in values, or at all events a lasting one. I may say that I have heard this morning that the control has been taken off tin, and I think there were symptoms yesterday in the market of a demand for the metal, and there was a certain amount of stability which has been lacking for some time. There was also an inclination to make forward contracts. I merely hazard these few observations, but, as I before observed, it is impossible, under present abnormal conditions, to do more than make a guess at what may happen. One thing, I think, is certain, that any heavy fall in value would make it impossible for many mines, not favourably situated, to carry on. I think that is undoubtedly the case, not only in Nigeria, but also in some parts of the Straits, and, I think, in Cornwall, though Mr. Wethered knows more more about that than I do. Here comes in a factor which will operate very strongly in the future in favour of our company, namely, cheapness of production

Two things have happened during the past year which will, I am sure, be of great benefit to the company. The one is the acquisition of the water rights in the Kwall Falls, and the second, the arrangement with such an excellent firm as Messrs. Vickers to put up the required installation. Major Canning is here present to-day, and is starting early next month for Nigeria, where he will assist in the commencement of the necessary operations for the instalment of the water power, during the absence of our present manager, who is due for leave. Major Canning is going to second the resolution I am about to propose, and I am leaving it to him to say a few words as to the difference this installation is estimated to make, both as to cost of production and quantity of tin produced.

Since this speech was compiled we have had a cable giving the result for last month, and I hope none of you will be unduly depressed at it being small. The quantity is 25 tons, but it is entirely due to the absence of labour owing to influenza. Well, gentlemen, I do not think I have anything more to say to you, and I am sure you want to hear Major Canning, so I will now read the resolution which I propose. Major Canning will second it, after which, if there are any questions you would like to ask, I shall be very pleased to answer them. I beg formally to propose: "That the accounts to June 30, 1918, together with the reports of the directors and auditors thereon, be, and they are hereby received and adopted, and that a final dividend at the rate of 12½%, less tax, on the preference and ordinary shares, making 25% less tax, on the preference, and 15% less tax, on the ordinary shares for the year ended June 30, 1918, be and is hereby declared."

Major A. R. Canning said: Gentlemen, although I had the opportunity of meeting you last year, I was somewhat embarrassed by your extreme kindness at the time, so that I missed the opportunity of saying anything other than words of thanks. As you know, I have been connected now with this property for five years, but hitherto I have never had the opportunity of giving you a description of the property. There is so much to cover this morning that I must be very brief indeed. Now, with regard to last year's work, our tonnage was a little down—some 20 tons. That was entirely due to shortage of labour. The management has always the dual duty to perform, first to keep up the output of tin, and secondly to look ahead and to prospect. Last year Mr. Andrews kept up the prospecting splendidly in spite of shortage of labour. During the last four years we have totalled nearly 100,000 ft. of drilling and pitting, which, if it is all put together, approximates 18 miles. This work has been going on parallel with tin winning. The results of the prospecting last year were not so great as in the previous year, but we are something like 500 tons, or over £80,000 to the good in value, in spite of having depleted the property by the year's production of 535 tons. Details of the work are to be found in Mr. Andrews' report.

Now, I will say a word about the Kwall Falls power. Over two years ago, having secured reserves for the next three or four years, we turned our attention to the lower reaches of the river, and spent a great deal of time in close boring, but with disappointing results. I then instructed that boring should be started right away from the present river, and this led to immediate and remarkable results. Tin was found 400 yards away from the banks and under a depth of no less than 80 ft., and many of these bores were very rich. Immediately on this discovery being proved beyond doubt, the question of securing cheap power to remove this heavy overburden became imperative. I, therefore, with the consent of the directors, looked round to see whether we could not get this. Such power was to be obtained by harnessing the Kwall Falls. Its position with regard to the property can be seen on the plan. The red markings on the plan represent the leases along the stream beds. The river here leaves our property and goes on for about 10 miles and then drops over the edge of the plateau, a depth of from 700 to 800 ft. Here, then, was the power if we could get it. There did not seem to be insuperable engineering difficulties, but the point was to obtain the concession from the Government. In this, after long negotiation, we were successful in securing an option. The next thing was to confirm our opinion as to the practicability, and last year Messrs. Vickers sent a representative out there. He was three months on the ground, and he corroborated all our figures.

This electric power means a saving of about £40,000 a year in fuel. The proposal is, as will be seen from the plan, to pick up the water some two miles above the falls and lead it through a leat of 12,000 ft. into pipes which will convey the water to the power station at the bottom of the Falls, the vertical depth being over 700 ft. The power thus generated will be carried over a transmission line of 12 miles to a central point on the property. The horse power then will be 1,500, and obtained at a very low cost per unit, the estimated figure being 0·6 of a penny, as against 2·6d. if oil or coal were used. Now, what does this mean to the company—this cheap power? It means, roughly, that instead of only working at a profit ground down to 2¼ lb. per cubic yard and leaving ore below that representing several million cubic yards, we can certainly work 1½ lb. ground, and probably a good deal lower, but that, of course, depends on the price of tin. With tin at £200 per ton of metal, and working 2 lb. ground, a profit of between £60,000 and £70,000 per annum should be made. This relates only to working eight months in the year. Should a dam, for which an excellent site has been secured, be constructed, at an additional cost to the present scheme, work can be carried on throughout the year and the profit be increased.

It is not only that the profits will be largely increased, but the life of the company also should be practically doubled by securing this cheap power. I may say of the reserves of tin, which you see in the report are stated at 7,324 tons, most of it is rich ground—3 lb. to 3½ lb. ground—but if we were to include the lower grade ground we should have a much larger figure than that. I think that is very satisfactory. The reserves, as they now stand, amount to £1,250,000. The agreement for these Falls is for 21 years. I am going out in January to take Mr. Andrews' place while he is at home, and also to get ahead with this power scheme. There is only one fly in the ointment just now, and that is labour. Mr. Hetherington White has referred to the shortage of labour, which accounts for our decreased output. This big water scheme means that we shall be far less dependent upon labour. As each year goes by water is being made more and more our servant. Every year we get more independent of native labour. At the same time, the shortage is rather serious at the present moment, but with the passing of the influenza epidemic and also the disbanding of the native troops, we shall have an improvement. I do not think there is anything else I can say to you. I beg to second the resolution, and I shall be very pleased, if I have not made anything clear, to answer any questions.

The resolution was then put to the meeting and carried unanimously.

Mr. G. Temple Harris proposed the re-election of the retiring directors, Major A. R. Canning and Mr. Hetherington White.

Mr. Oliver Wethered seconded the motion, which was also carried unanimously.

The auditors, Messrs. Annan, Dexter & Co., were reappointed.

A hearty vote of thanks was accorded to the chairman, the directors, and the management on the other side, and the proceedings then terminated.

BONGWELLI (NIGERIA) TIN SYNDICATE, LIMITED.

Directors: A. W. Kitson, T. Lees Field (*Managing*), J. H. Spaull. *Acting Secretary:* E. J. Davison.
Office: 24, Coleman Street, London, E.C.2. *Formed* 1913. *Capital issued:* £25,000, in shares of 5s. each.

Business: Operates alluvial tin ground in Northern Nigeria.

The ordinary general meeting of the Bongwelli (Nigeria) Tin Syndicate, Ltd., was held on December 20 at the Institute of Chartered Accountants, London, E.C., Mr. T. Lees Field (managing director) presiding.

The Secretary having read the notice calling the meeting,

The Chairman said: In 1914 Major Kitson retired from the board saying he hoped to return after the war. I am glad he is now by my side. Mr. Spaull is in the Far East, but is represented by Mr. J. E. Craig, his alternate. I am pleased to tell you that we shall shortly be joined by a representative of the Niger Company, Ltd. You have before you the directors' report and balance sheet, and, as usual, I suggest that we take them as read. We meet under happier circumstances than last time, but we wish that the balance of profit and loss had been the other way. However, after all our troubles, many of which are unknown to you, I venture to think the position and prospects can be considered quite satisfactory. This has mostly been brought about by the devoted and untiring efforts of your manager, Mr. V. W. Boyle, who made it possible for the directors to enter into new business and so resuscitate the fortunes of the company. We believe in giving praise where praise is due, and I can tell you that we owe our existence to the broad-minded policy of the Niger Company as displayed by Mr. J. E. Trigge, their managing director. Our thanks are due to the company. I could say a good deal about the treatment we received in official quarters, but refrain from doing so. A man knows much who knows when to speak, but a man knows far more who knows when to hold his tongue. As was only to be expected when developing a new country, more knowledge is being gained as to the tin deposits of Nigeria, and ground which was passed over many times and by many people has recently been taken up and is adding to the output of the country.

I do not think it will weary you if I venture to express briefly my own views on the position generally. The winning of alluvial tin presents no great difficulty and follows lines more or less generally known, but in every case the nature of the deposit has to be studied and the method of work determined. Tin deposits exist which from their position and natural difficulties cannot be worked profitably. A great many deposits are low-grade, and to get rid of the impurities costs so much that no profit can be made. You will be glad to hear that the information we have is that our properties are most favourably situated for working economically, while, being on the Delimi river—which drains the plateau where the principal producing mines of to-day are situated—we have water all the year round, and hold properties which can be worked in both the wet and the dry season. Again, there are deposits of tin in lode or other formation which every wet season feed our properties in the natural order of things. This means that we should have a longer life than many properties which have definite deposits to work out. Your manager and the board have been giving close attention as to how we can assist Nature in yielding up its treasures of tin on our holdings, and hope that we may be able to expedite it by means of improved methods, and thus reduce costs and increase production.

I have now a little surprise for you. For about eight years now we can say that the tin deposits of Nigeria have received serious attention at the hands of mining engineers, and many have been working the deposits, while more have paid visits for the purposes of prospecting and inspecting or proving known deposits. I feel sure I am right in saying that no one has, as a result of his work in Nigeria, improved any old appliances or invented any new one to expedite or assist recovery; at any rate, I know of none. I think, therefore, that we can rightly congratulate our manager, Mr. Vicars William Boyle, for having worked out and demonstrated in the only satisfactory way, namely, working on a practical basis, the means of dealing profitably with lower grade concentrates than have been worked previously. He did not announce this from the housetops, but his knowledge has been the means of our acquiring properties through him which we have every reason to believe will resuscitate our fortunes and enable us to join the dividend-paying companies. A very universal tin-dressing plant used in Nigeria is the "Australian Willoughby." Some time ago, Mr. Boyle vastly improved this machine, and showed its working to the engineers of our good friends the Niger Company and others, who saw its advantages and adopted the alterations. No patent has been, or will be, applied for; Mr. Boyle gives to the mining industry the benefit of the Willoughby improvements and the quicker and more effective dresser for low-grade deposits, for which I think he deserves the thanks of all. It is with pride that I am able to announce this to you, Mr. Boyle being my closest friend and our manager. He has been away now four years doing his bit in winning minerals during the disastrous world war and has worked hard. I am glad to tell you that we have secured the services of Mr. E. S. King, the Australian mining engineer, so well known in London and Cornwall, who has gone to Nigeria to relieve Mr. Boyle, who is coming here for a well-earned holiday. Many of you who know him will, I know, be glad to see him again.

One more point, and that the price of tin. It seems to me that all we now require is a fair and reasonable price for our tin concentrates during, say, the next decade, and on this price will depend the size of dividends. It must be satisfactory to know that we can recover our tin at a cheap rate, and that it would seem that our success is assured for many years to come. I beg formally to move the adoption of the report and balance sheet.

Lieut.-Colonel A. W. Kitson, M.C., seconded the motion, which was carried unanimously after a brief discussion.

An extra-ordinary general meeting was then held at which resolutions were unanimously passed authorizing the increase of the capital of the company from £37,500 to £62,500, in 5s. shares, 100,000 of which are to be issued as consideration price for the purchase of properties, to be the subject of an agreement with Mr. V. W. Boyle.

JANTAR NIGERIA COMPANY, LIMITED.

Directors: E. W. Janson, P. C. Tarbutt, Oliver Wethered. *Secretary:* E. J. Hayman. *Office:* 18, St. Swithin's Lane, London, E.C. *Formed* 1912. *Capital:* £60,000.

Business: Operates alluvial tin ground in Northern Nigeria.

The sixth ordinary general meeting of the shareholders of the Jantar Nigeria Co., Ltd., was held on December 19 at the offices of the company, 18, St. Swithin's Lane, London, E.C., Mr. Oliver Wethered presiding.

The Chairman, in moving the adoption of the report and accounts, said that the period covered by the accounts was certainly the most interesting in the history of the company, and might prove to be the most important, as they had secured new business on the strong advice of their manager. They certainly might claim a record of success, for since the company was formed in May, 1912, £37,000 had been distributed in dividends. The profits of the past year were £15,216 as compared with £15,730. The very high price ruling for tin would perhaps have led the casual shareholder to expect a much larger profit, but those more closely in touch with the field were prepared to find that the very high cost of materials, the sliding scale of royalty, and insurance would materially add to the cost per ton. Then there was the question of native labour, of which there was a great scarcity due to the absence of a very large number of the natives, who were acting as carriers in connection with the Nigerian Expeditionary Forces. This reduced production necessarily helped to swell the standing charges and the high cost per ton, but they had the satisfaction of knowing that the cassiterite remained for future working under more normal conditions as regards cost of supplies, freights and supplies of native labour. The same profit, within £700, would appear to justify the same rate of dividend as on the previous year, but they were face to face with the excess profits duty, and must for the moment rest content with the 3s. paid instead of 5s. in the previous year. However much they might regret this, they must not forget that their good prewar standard had saved them from any previous payment in this respect, whereas some companies operating in Nigeria had suffered heavily. Those who could not fight were willing to pay their share of taxation, but it was agreed on all hands that the incidence of the excess profits duty was most inequitable, and it was generally thought that it would cease to exist very long in its present form. Meanwhile, they had to make provision for the amount, and they were not justified in making any further distribution in respect of last year. He hoped, however, in the new year, if their tin came forward expeditiously, they would make an interim distribution on account of the current year.

At the last meeting he said "the policy of the board is to build up the company to a permanent concern with a very long life, and I am sure that in that policy we shall have your hearty co-operation." With this in view, and on the strong recommendation of their manager, they had secured a substantial interest in the Kuru Syndicate, Limited, and with their immediate associates—companies or individuals—they controlled that company. The purchase price was one of the largest paid for any property in Nigeria, but they were advised that the reserves already proved, and the promising nature of the large area of untested ground, justified the figure. An output of about nine tons per month was now being made, and this should be more than doubled during 1919; and, if labour was available, and it was deemed wise to do so, they could very largely exceed even that doubled figure. The total capital of the syndicate was only £60,000 in 5s. shares, £10,000 of which represented working capital. The Jantar Company, on whose behalf the negotiation was carried on, made no direct profit on the transaction, but they retained an option on two adjoining areas, which might prove to be a source of considerable benefit. The working of the two properties under the well-established organization and experienced management of the Jantar Company materially affected the economical and efficient administration of the two undertakings. In conclusion, he would like to say how much they appreciated the work done by their manager and staff in Nigeria.

Mr. Percy C. Tarbutt seconded the resolution.

The Chairman said that the option to which he had referred, on these two properties immediately adjoining the Kuru, looked to him as though it would be extremely valuable, and in order that the company might take full advantage of it, it was probable that at no distant date they would call shareholders together and suggest a moderate increase in the capital of the company. If they did so, they would take the opportunity of doing what many large shareholders had often urged, splitting their shares into a denomination of 5s. There were only 60,000 shares at present, and in the event of death, or sudden desire on the part of a holder to sell a considerable number, the market was far more limited in a £1 share than it would be in a 5s. share. If they did this, it was their intention to give shareholders the benefit of the issue pro rata

After a few questions had been replied to, the resolution was put to the meeting and carried unanimously.

The Chairman proposed the re-election of Mr. P. C. Tarbutt, the retiring director.

Mr. Fawns seconded the motion, and it was unanimously agreed to.

The auditors (Messrs. Annan, Dexter and Co.) having been reappointed, the proceedings closed with a vote of thanks to the Chairman, directors and staff, both at home and in Nigeria, for their work during the past year.

TIN FIELDS OF NORTHERN NIGERIA, LIMITED.

Directors: S. R. Bastard (*Chairman*), F. N. Best, C. G. Lush. *Secretary:* A. J. Culley. *Office:* Friars House, New Broad Street, London, E.C.2. *Formed* [illegible]. *Capital issued:* £70,007 in shares of £1 each.

Business: Operates alluvial tin properties in Northern Nigeria

The fifth ordinary general meeting of the Tin Fields of Northern Nigeria, Ltd., was held on December 12 at Friars House, New Broad Street, London, E.C., Mr. Segar R. Bastard (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31 last, said that the company was in a far better position than it had ever been in before. It seemed most extraordinary that they should find themselves possessed at this period of what had proved to be, after careful prospection of only a small portion of it, a property with a life of nearly twenty years, taking the previous ratio of tin-winning. That in itself was most highly satisfactory, but there were also tremendous possibilities in their Lower Fedderi area. That was the one that appealed to their engineers most of all, as in addition to the other runs of tin that had been found in Fedderi, there were the greatest probabilities of finding entirely fresh runs of tin on Jarawa. How far they extended down was not known, but they would have gathered from Mr. Hannam's report that there were in this property various small creeks that ran into it from the hills; some of them were tin-bearing and some were not, but those that were tin-bearing would in all probability have enriched the flats at the mouths of these creeks. Shareholders heard him on previous occasions express the opinion (given him by the engineers who had been working on the property) that it was of no use, and would have to be abandoned in six months or so, but he must say that his co-director, Mr. Best, had always been firmly of the contrary opinion. Mr. Best was a man of very solid convictions, and in this case his convictions had been borne out. He had always said that nothing could stop tin being in the valley of this basin of the Lower Fedderi. That was a very satisfactory state of things. The cash position was also very satisfactory. They could have paid a dividend in respect to the year under review, but they had had to bear in mind the fact, first of all, that they had a very big property. In respect to that, Mr. Hannam said in his report that apart from any new pipeline—and that was not immediately required—a total expenditure of £300 would cover all the requirements they could foresee at the present moment. In these circumstances, they were well justified in proposing an interim dividend of 5%, less income tax, for the current year. He had taken the opinion of a first-class expert, and was satisfied that the company was not liable for excess profits duty.

Mr. F. N. Best seconded the resolution, which was carried unanimously.

NARAGUTA (NIGERIA) TIN MINES, LIMITED.

Directors: F. N. Best (*Chairman*), John Waddington, Sir E. A. Speed. *General Manager in Nigeria:* F. O'D. Bourke. *Consulting Engineer:* C. G. Lush. *Secretary:* A. J. Culley. *Office:* Friars House, New Broad Street, London, E.C.2. *Formed* 1910. *Capital:* £175,000

Business: Operates alluvial tin properties in Northern Nigeria.

The eighth ordinary general meeting of the Naraguta (Nigeria) Tin Mines, Ltd., was held on December 30, at Winchester House, London, E.C., Mr. Frank N. Best (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31, 1918, said that the extra heavy costs were largely due to the war, as explained at their last meeting. This was now happily over and they must turn their attention to bringing costs back to as near as possible the pre-war standard. Insurance, which had been quite a large item during the last few years, would, of course, drop to the normal. There were other increased charges, such as travelling, cost of native labour, and the increased cost of freight and passages, which were more difficult problems, and some considerable time must elapse before they could be brought down. There was, however, one question which might be in the minds of some shareholders, and that was, considering the high price of tin, why an effort was not made to increase the output. With the shortage of white staff and native labour, this could only have been done by paying high prices for tribute labour and picking the eyes out of the property, which would have meant absolute ruin to the property as a mine, and would have brought them face to face with the prospect of liquidation as soon as the price of tin fell to anything like its normal level. Some mines were, no doubt, adopting that suicidal policy, and it was, he regretted to say, not an unnatural consequence of the policy of the Colonial Administration which was endangering the healthy growth of a huge industry by refusal of a little sympathetic treatment, and sacrificing a large potential revenue for the sake of a really insignificant present gain. They would doubtless remember a few years ago their general manager reported that, in his opinion, the Naraguta property was a fairly low-grade proposition, but if worked in a miner-like way they had twenty years' life before them, and he recommended a policy which was endorsed by the board. They proposed to continue on those lines which he had no hesitation in saying would ensure a life of at least twenty years, and he felt confident, when they came to have a full knowledge of their property, it would be a great deal longer. The general manager, in his letter covering his annual reports, made the following remarks, which were very interesting: "Much ground has been worked, but the portions considered useless at one time have been proved to contain useful values. The areas are on the whole low-grade, and every effort requires to be given to increasing the yardage of ground mined, especially in regard to the deep ground. More pipes will be necessary, but not for probably two or three years—perhaps more. If, however, they were available at the moment they could be used to advantage." It was evident from these remarks that their best policy to counteract any increased cost of native labour or possible fall in the price of the metal was to produce more tin by sending out extra pipes so as to utilize to the utmost the water-power during the wet season, as that was the cheaper method of producing tin.

They could hardly do otherwise than continue to work on these lines, which he thought was the only sound policy for a good commercial enterprise, and as long as the present abnormal prices were ruling good profits would certainly be made, but if the present form of Government administration was allowed to go on, he foresaw grave danger to the industry as soon as the price of the metal again became normal. He was one of many who firmly believed that, given proper administration, the tin industry of Northern Nigeria would last very many years and bring an enormous revenue to the country, but he entertained no doubt that the industry would be gravely imperilled, if not actually destroyed, by a continuation of the thoughtless policy of the present Administration, and some of the miners—the former by seeking to increase the revenue during their term of office and the latter by picking the eyes out of their properties, both of them taking no heed for the future or for those who might come after them. The two great mistakes instituted by the present legislation were: (1) tributing; (2) the granting of mining rights. Tributing, because it dislocated and was steadily increasing the cost of native labour, which every manager knew could not appreciably be brought down again. The granting of mining rights, because it dislocated the white staff of the mining companies, some of whom, after having been trained at the expense of a company, left at the end of their agreement, sometimes before, and took up a mining right on their own; then, by giving higher wages, enticed away the better-class labour from their old companies and other companies surrounding them.

Mr. John Waddington seconded the motion, and it was carried unanimously.

The Chairman proposed the resolution that the appointment of Sir E. A. Speed as a director of the company be confirmed. Sir E. A Speed's many years' experience in Nigeria as Chief Justice, and his knowledge of the claims put forward by the mining companies for more sympathetic treatment, would enable him in time to bring about a better understanding between the mining interests and the Administration. The Chairman added that he was not satisfied with the fact that they were so long in getting their accounts out. This year they had suffered very considerably from influenza in the City of London, which had reduced available labour at the command of the auditors. They had also suffered very heavily in Nigeria, though, fortunately, they had not had any deaths among the white staff, although they had a very heavy death-roll among the native staff in Nigeria which reduced the output for a few months.

Mr. Waddington seconded the motion, and it was carried unanimously.

SOUTH BUKERU (NIGERIA) TIN CO., LTD.

Directors: S. R. Bastard (*Chairman*), John Waddington, W. A. Luning. *Consulting Engineer:* C. G. Lush. *Secretary:* P. S. Fitzer. *Office:* Blomfield House, London, E.C.2. *Formed* 1910 *Capital issued:* £44,807.

Business: Operates alluvial tin ground in Northern Nigeria.

The annual general meeting of the South Bukeru (Nigeria) Tin Company, Ltd., was held on December 19, at Winchester House, London, E.C., Mr. S. R. Bastard (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, said that the output of black tin was somewhat less than in 1917, due to the fact that they had not had this year a rich pocket of tin such as they had the previous year. After deducting the interim dividend of 5% paid in August, there was a balance to credit of profit and loss of £13,563. He had received letters from shareholders suggesting that the position justified further dividends. The directors were themselves quite anxious to do this, but, taking everything into consideration, they had decided that the utmost they could do was to pay 5%. They were spending a considerable sum in developing the property to enable it to be worked economically, and on a larger scale. Complaint had also been made about their setting aside £4,000 for excess profits and income tax, part of which would only be wanted in the coming year. At the present moment they were developing the property, and it might be that they would not produce the amount of tin they otherwise would have done, and it was for this reason they considered it perfectly wise to keep that amount of cash in hand. Their properties were large, considerably over 1,600 acres, and having visited the property himself, and heard what their engineers had to say about it, he believed they had in it a very large amount of payable ground, proportionately more than any other property he had seen in Nigeria. In fact, he was satisfied that they had a very valuable property indeed, and if they took it at the value placed in the balance sheet of £36,000, he felt that it was most moderately estimated, and that anyone who knew what it was would be willing to give a much higher sum for it. They had in Mr. Hueston, their consulting engineer in Nigeria, a man with very close knowledge of tin properties there, and under his advice there was no doubt that it would be properly managed and developed. As the price of tin had fallen their output would have to be increased, but he looked forward to the future with confidence.

Mr. W. A. Luning, in seconding the resolution, expressed satisfaction that they had been able to start a reserve fund, on his suggestion, and he hoped that in future a portion of their profits would be added to it. He hoped himself soon to go out to Nigeria in order to make himself acquainted with the property. He was not a mining expert, but a business man, and very often a business man could see things better than a mining engineer.

The resolution was carried unanimously.

Mr. S. R. Bastard was re-elected a director, Mr. W. A. Luning's appointment to the board was confirmed, and Messrs. W. Arthur Addinsell and Co. were reappointed auditors

KEFFI TIN COMPANY, LIMITED.

Directors: G. T. Broadbridge (*Chairman and Managing Director*), M. H. D. Beresford, C. Wallington. *Secretary:* A. H. Dwight. *Office:* 32, Sackville Street, London, W. 1. *Formed* 1912. *Capital:* £50,000.
Business: Works an alluvial tin property in Northern Nigeria.

The ordinary general meeting of the Keffi Tin Company, Ltd., was held on December 18 at Winchester House, London, E.C., Mr. G. T. Broadbridge (Chairman and managing director) presiding.

The Chairman, in moving the adoption of the report for the year ended June 30 last, said that the output had amounted to 160 tons of tin, of a gross value of £37,175, so that the year had been the most successful the company had had during its existence. After deducting the cost of production, including freight, insurance, royalties, &c., there remained a profit on trading account of £17,906. From this sum must be deducted the items standing to the debit in profit and loss account, leaving £16,399 to be dealt with, and it was proposed to appropriate this in the following manner: In the payment of the company's first dividend of 12½%, absorbing £6,250, less tax, writing off the loss on previous accounts, £7,199, writing off prospecting and development account £1,000, and carrying forward a balance of £1,147. From the results which the company had shown it would be quite evident that in the properties which the company possessed, particularly the Amari, it had possession of important areas. The Amari property was a lease extending over 115 acres, from which the main output was obtained. A similar deposit was located in another part of the property a few months ago, and in consequence an additional lease was applied for to cover the extensions of this deposit beyond their boundary. The exact area of this additional lease would presumably be about the same as the Amari itself. In addition to this, they held another lease of 33 acres at Randa, a few miles away from Amari, and two mining rights, one of them covering one mile of stream on the Amb creek in the immediate vicinity. In addition to the ground from which their output was being obtained there was a reserve of ore of a different character which would be dealt with at a later stage, when certain crushing plant which Mr. Thomas required was installed. The average value of this particular ore was about 40 lb. black tin to the ton. There was an estimated tonnage of this ore at present of about 16,000 tons. Mr. Thomas stated that considerable ground still remained to be explored, especially between the new and main sections, which would be carried out while the dry season was on. A good native camp had been erected on the property, and this, together with a native traders' market also installed there, had been the means of securing and keeping a good labour supply.

With regard to the policy of the board, more particularly with regard to the future, he would say at once that it was their intention to pursue a progressive, and vigorously progressive, policy. It was important, in his opinion, in the case of alluvial properties, to acquire from time to time other alluvial areas, and thus be able to increase the output as well as prolong the company's life.

Mr. Charles Wallington seconded the motion, which was carried unanimously.

CAPE COPPER COMPANY, LIMITED.

Directors: T. Blair Reynolds (*Chairman*), J. E. Champney, John Taylor, J. M. V. Money-Kent, M. Paisant, C. Cahen d'Anvers. *Secretary:* P. J. Franks. *Office:* 9, Queen Street Place, London, E.C.4. *Formed* 1863, reconstructed 1888. *Capital issued:* £[illegible] in preference shares, and £720,000 ordinary shares, both in shares of £2 each.
Business: Works copper mines in the Cape Province, South Africa; has developed a copper deposit in India.

The thirty-first ordinary general meeting of the Cape Copper Company, Ltd., was held on December 18, at 9, Queen Street Place, London, E.C., Mr. T. Blair Reynolds (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended August 31 last, said that owing to lack of coke the smelter at the mine ran for only 170 days, with a consequent reduction in output of more than half compared with that of the previous year. The great falling off in their returns for copper ore and metal from £317,142 in the previous year to £87,328 was primarily due to this largely reduced output. There was a net decrease on the items comprising mining costs and freight of £20,354, and very slight set-off against the large reduction in the returns. Another adverse feature in the year's working was the serious increase of working costs at the Briton Ferry smelting works, in South Wales, where continual additions to the rates of wages had, together with advanced cost of material, caused the operations to be carried on at a loss. Foreseeing the consequences of a reduced output, the directors a year ago considerably increased the amount carried forward. The net result of the profit and loss account was a credit balance of £6,912, out of which they were paying the preference dividend for the latter half of the year. Their old mines in the Cape Province were not likely to be worked out for a few years yet. It was, however, to the Rakha Hills mines in India that they must at present look for the renewal of the prosperity of the company. They had at this property already produced a small quantity of blister copper assaying 99·8%, and it would only be a few weeks before the complete plant for producing refined copper would be ready to work. The reserves had been somewhat increased during the year, and now stood at about 450,000 tons, averaging 3·69% copper. Certain prospecting work had been done some miles from Rakha which might have an important bearing on the future of their Indian enterprise. At a depth of 80 ft. a lode had been cut which was similar in width and value to that at Rakha. It was the intention of the board to carry on investigations of the mineral belt which ran through the prospecting area, as the discovery mentioned opened up large possibilities.

Mr. J. E. Champney seconded the motion, which was carried unanimously.

MIDDLEBURG STEAM COAL & COKE CO., LTD.

Directors: Alan Cadell (*Chairman*), Alfred T. Macer (*Managing Director*), Edward Bedford, W. E. Martin. *Secretary:* E. J. Townsend. *Office:* 52, Queen Victoria Street, London, E.C. *Formed* 1906. *Capital issued:* £64,899 in preference shares and £99,888 in ordinary shares, both of £1. Debentures £14,250.

Business: Operates a coal mine in the Transvaal.

The thirteenth ordinary general meeting of the Middleburg Steam Coal and Coke Company, Ltd., was held on December 16 at the London Chamber of Commerce, Oxford Court, Cannon Street, London, E.C., Mr. Alan Cadell (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said that the trading profit showed the very serious diminution of £5,000. This loss of profit occurred entirely in the second half of the year. The floods in January swamped the mine and also stopped the output, and they were for some months engaged in pumping a large body of water out of the colliery. There was no record of such an abnormal rainfall, and it was to be hoped that it would not recur. The working costs were also largely increased by the rise in wages and materials, which was not compensated for by a corresponding rise in the price of coal. The members of the Transvaal Coal Owners' Association could not be accused of profiteering. Last year their coal realized approximately 6d. per ton only above the price for the year to June, 1914, while the costs per ton showed an increase of 1s. 3d. to 1s. 4d. per ton.

After paying debenture interest, preference dividend, and an interim dividend of $3\frac{3}{4}$% they had £7,428 left, out of which they proposed to pay a final dividend of $3\frac{3}{4}$%, which would leave £4,184 to carry forward. While the year had in many respects been a disappointing one, the causes were not under their control, and they trusted that the current year would lead to more normal times. Unfortunately, the influenza epidemic in October affected the collieries most seriously. At their colliery 90% of the natives and practically the whole of the European staff were down with it, and there were some 25 deaths, including, he grieved to say, the wife of their general manager, Mr. E. M. Goodwin, who had devoted herself to the work of nursing the sick.

The output for November of 23,481 tons was almost normal, and they trusted that with peace they were at the end of their trouble.

Mr. Alfred T. Macer, the Managing Director, in seconding the resolution, said that, with regard to the question of the small price of the coal, this was rather a sore point in the Transvaal. The internal coal trade was looked upon as a source of profiteering, but they would see from the price realized for their coal—5s. 2d. per ton—that there was certainly no profiteering so far as the mines in the Transvaal Coal Owners' Association were concerned, and they output 90% of the coal. The only chance of making a higher price was with regard to the comparatively small proportion of the trade which dealt with export coal. The trade was a healthy one, and was increasing yearly, but even now it was only 13% of the total output of the Transvaal collieries. In Durban the price was something like 3s. per ton more than the pre-war price. That was owing to the fact that the Natal trade was as to over 50% an export trade. Natal was in the fortunate position of having its own port, Durban; the Transvaal had the use of perhaps one of the finest ports in the world, but unfortunately it was a Portuguese port, and there were considerable difficulties in working a trade to the best advantage through a foreign port. The general effect of war upon the coal trade there had been not to put up the price, and he was rather surprised that these coal resources of the Empire had not been taken fuller advantage of in time of war. They had been taken very little advantage of, no advantage of at all for munition purposes; and practically the by-products of the collieries had been neglected. In peace times they should have the advantage that these coal resources were there, and although he, for one, did not anticipate or expect or hope that a higher price would be charged for coal internally, he did expect that a higher price would be obtained for foreign coal, and certainly the coal should be used far more economically in South Africa itself. A large proportion of the small coal had not been utilized at all. It was dumped on the collieries. He believed they had something like 500,000 tons of small coal dumped at their colliery alone, and within 3 or 4 miles of the big centre, Witbank, there were 5,000,000 or 6,000,000 tons of small coal dumped which contained volatile products equal to 30 to 35 gallons per ton. If a central plant were put down at Witbank, as he had advocated for years past, it could treat the whole of this small coal that was dumped now and the small coal that was made, and the profits of the collieries ought to be increased by at least 50% from the same output of coal as was obtained at the present day. A combined plant was an essential thing for a treatment plant of this kind, because they had not only to deal with the volatile products, but they had also to deal with sulphate of ammonia, which, in an agricultural country, was of the very greatest value, and was now being entirely wasted. He submitted that this was a question that the Union Government of South Africa ought to take up seriously, either by advancing through a central company money at a low rate of interest to put up a big plant capable of dealing with, say, 100,000 tons a month, or in some way by assisting the collieries, or even by takiug over the dumps themselves and making it a Government scheme to deal with these resources, which were only one of the great resources of the Union of South Africa. He thought there was no other question that pressed at the moment. He would not attempt to prophesy as to the future. He did not think that for the current year they would increase the dividend, as they had suffered very severely by the influenza epidemic; but he did think that in future years, with peace and a normal trade, they would certainly place the company on a $12\frac{1}{2}$% dividend-paying basis, and he hoped that next year would see that level reached.

The resolution was put to the meeting, and unanimously adopted.

Mr. Macer proposed a vote of thanks to Mr. Lathom, the business manager, to the general manager and to the staff, and that a grant of 100 guineas be made to Mr. Lathom.

A resolution in these terms was unanimously adopted, and a vote of thanks to the Chairman, the managing director, and the other members of the board concluded the proceedings.

AFRICAN & EUROPEAN INVESTMENT CO., LIMITED.

Directors: Isaac Lewis (*Chairman*), George Falcke, Louis Marks, Samuel Marks, Julius Weil. *London Board:* J. B. Hilliard, H. D. Lewis, C. F. Rowsell. *Secretary:* R. W. Townsend. *Office:* Lewis & Marks Building, Johannesburg. *London Manager and Secretary:* A. D. Owen. *London Office:* 34, Bishopsgate. *Formed* 1904. *Capital issued:* £1,168,346.
Business: The financing and development of land, mines, etc., in the Transvaal and Rhodesia.

The fourteenth ordinary general meeting of the African and European Investment Company, Ltd., was held on December 31, at Threadneedle House, London, E.C., Mr. C. F. Rowsell presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June, 1918, said that they had received by way of dividends, debenture interest and sundry profits £10,892. 9s. 3d., as against £7,040. 7s. 5d. last year. Rentals and farm revenue amounted to £12,997. 12s. 1d., as against £11,759. 4s. 6d. The total receipts for the year amounted to £23,890 1s. 4d., against £19,942. 10s. 3d. The administration expenses amounted to £5,258. 18s. 6d., as against £4,225. 14s. 8d. The result of the year was that they carried forward a profit to the balance sheet of £9,235 11s. 10d., as against the profit last year of £1,202 16s. 8d. This was a very satisfactory improvement in the condition of their assets. His colleagues, Mr. Isaac Lewis and Mr. Marks, who were second to none in their knowledge of South Africa and its land, were still of opinion that land values would rise very substantially. Nevertheless, a programme was being considered to commence selling their land on terms which were likely to be satisfactory both to the company and to farmers. A scheme was under consideration for forming an organization for directing emigration to South Africa on right lines, and it was hoped that this organization would be one which would receive the support not only of an individual landowning company, but of all the landowning companies who had large interests in South Africa. An interesting development had been the remarkable increase in the industrial development of South Africa. The Union Steel Corporation had been largely responsible for supplying to the railways and the mines their requirements of steel products during the war, and they had already established in South Africa two blast-furnaces for the production of pig iron, one of which was situated on the Vereeniging Estates. The company had also very considerable interests in mining in various parts of South Africa, and no doubt the great possibilities of the East Rand Mining Estates, in which they owned about 50,000 shares, were well known. In Rhodesia they had a large holding in the Rhodesia Gold Mining and Investment Company, whose principal assets consisted of large holdings in the Lonely Reef, Cam and Motor, Sabi Gold Mining and other valuable mining assets; while in the Lonely Reef itself they owned nearly 10,000 shares

Mr. J. B. Hilliard seconded the motion, which was carried.

EAST RAND MINING ESTATES, LIMITED.

Directors: C. F. Rowsell (*Chairman*), Isaac Lewis, Barnet Lewis. *Secretary:* A. D. Owen. *Office:* 34, Bishopsgate, London, E.C. *Formed* 1901. *Capital issued:* £450,000, in £1 shares.
Business: Controls the Lewis & Marks mining interests in the Far East Rand.

The annual general meeting of the East Rand Mining Estates, Ltd., was held on December 17, at Threadneedle House, 43, Bishopsgate, London, E.C., Mr. Charles F. Rowsell (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, gave an account of the company's interests in the Far East Rand. They had two farms, Palmietkuil, in which they held a five-eighths interest, and Vlakfontein, where they owned the whole farm, both of which were situated on the reef, and in addition they held 253,020 shares in the Grootvlei Proprietary Mines out of an issued capital of 361,650 shares. On both the farms Palmietkuil and Grootvlei the main reef had been proved by a series of bore-holes, but a far more important proof had now been secured of the value of the deposits on these two farms by the development which had occurred on the surrounding properties. To the south of the farm Grootvlei was the farm Daggafontein, belonging to the Daggafontein Gold Mining Company, upon which developments of a highly satisfactory character had been obtained; on the west there was the farm owned by the Geduld Proprietary Mines, and on this property a very large amount of development had been done, and satisfactory profits were being earned and dividends paid. South of the Geduld, and still to the west of the Grootvlei, there was the lease granted to the Barnato Company, which had now been formed into a company under the name of the New State Areas, Ltd. South of this property, and again adjoining Grootvlei, there was the property of the Springs Mines, Ltd., and to the west again of the Springs Mines, Ltd., the mining lease which had been granted to the Anglo-American Corporation, Ltd., now known as the West Springs, Ltd. Of these properties the following had already large blocks of ore developed, namely: The Geduld, 2,200,000 tons of ore, valued at 7·5 dwt., and the Springs, 2,320,000 tons, valued at 9·5 dwt.; and these companies were earning respectively monthly profits at the rate of £22,000 and £18,000. With regard to the Farm Vlakfontein, there had been considerable activity in the farms adjoining this property, and the borings which had been carried out, together with the developments in the Sub-Nigel Mine, all went to prove that this farm could also be accepted as possessing the Main Reef. The steps which were taken by the board to prove the existence of a payable coalfield on Grootvlei were crowned with complete success, and Mr. Isaac Lewis, who had been in South Africa for some two years, had devoted himself to negotiating an agreement for the immediate development of this coal proposition. A company had been formed called the Largo Colliery Company, Ltd., with a capital of 110,000 shares of £1 each; this company acquired coal interests on the farms Grootvlei and Palmietkuil. The East Rand Mining Estates was to receive the whole of these 110,000 shares as payment for these coal rights.

Mr. Barnet Lewis seconded the resolution, which was carried unanimously.

MASHONALAND CONSOLIDATED (1912), LIMITED.

Directors: Frank Johnson (*Chairman*), F. J. Asbury, H. P. Clemes, Waller Hillyer, W. J. Stephens. *Manager in Rhodesia*: B. G. Derry. *Secretary*: J. J. Sneddon. *Office*: Finsbury Pavement House, London, E.C.2. ***Formed*** **1912.** ***Capital issued*****: £185,472 in shares of 5s. each.**
Business: Owns mining properties and mining rights in the Hartley, Salisbury, and Mazoe districts, Rhodesia.

The fifth annual general meeting of Mashonaland Consolidated (1912), Ltd., was held on December 31 at the office of the company, Finsbury Pavement House, London, E.C., Mr. H. P. Clemes in the chair.

The Chairman, in moving the adoption of the report and accounts for the year ended March 31, 1918, explained the profit and loss account, and reviewed the assets and mining and land properties. He proceeded to deal with the subject which was the most important at the present juncture, namely, the proposal for the reorganization of the capital of the company with its attendant provision of fresh working capital. For many years now the company's operations had been crippled for want of funds. They had been obliged to rely solely on tributing agreements for the preservation of the claim areas, and had been able to give no financial assistance to the tributers. The only means of raising capital previously suggested to the board was by means of the usual reconstruction scheme, with all its attendant expenses and hardships to those shareholders who were unable to take up their proportion of the new shares and pay the assessments. It was, therefore, needless to say that, having gone very fully into Mr. Kennedy's explanations of the probable financial results to be obtained from his suggestions, the board cordially welcomed the scheme to be submitted to shareholders that day as being one, not only original in its application, but based upon an equitable recognition of the rights of those shareholders who might for varying reasons be precluded from taking up any of the new shares. The ordinary shares, as explained in the heads of the scheme, took 80% of the profits, with priority as to capital in the event of liquidation, while the deferred shares, which would be held solely by existing shareholders, took 20% of all surplus profits. The agreement with Mr. Kennedy provided for a minimum of £20,000 of new working capital being subscribed, and on this basis the new cash capital would represent over 35% of the issued ordinary capital. Should the total number of new ordinary shares offered to shareholders be taken up, the new cash capital would amount to £74,000, or nearly 66% in cash, out of an issued ordinary capital of £112,280, while upon the option shares being taken up the new cash would represent £111,283, or 75% of the total ordinary capital of slightly under £150,000. Such a strong financial position should assure, with careful and energetic management, the accumulation of substantial profits for distribution.

Mr. Waller Hillyer seconded the motion, which was carried unanimously.

An extra-ordinary general meeting was then held, at which resolutions having for their object the reorganization of the company's capital were unanimously adopted.

LUIPAARD'S VLEI ESTATE & GOLD MINING CO., LTD.

Directors: A. Davidson (*Chairman*), W. Dereham, F. H. Hamilton, Sir Leigh Hoskyns, E. Turk. *Secretary*: W. Smith. *Office*: 10 & 11 Austin Friars, London, E.C.2. *Formed* 1888. *Capital issued*: £472,012; debentures £63,945.
Business: Works a gold mine in the western part of the Rand.

The twenty-third ordinary general meeting of the Luipaard's Vlei Estate and Gold Mining Company, Ltd., was held on December 18 at Winchester House, London, E.C., Mr. Alexander Davidson (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30 last, said that the loss for the year was the first for many years. This was chiefly accounted for by the war and the restricted price obtained for gold. The increased working costs were attributable to the war, and the reduced gold production was caused by scarcity of labour as well as largely to the disastrous floods in the early months of 1918, which were referred to in the directors' report. As illustrating the results of the changed conditions under which they were now working, he would compare the year under review with the last year before the war, ended June 30, 1914, in which they made a profit of £32,250. In that year they crushed 204,980 tons as against 246,910 tons last year, but, notwithstanding the increase of tonnage, the working expenses were now 2s. 6d. per ton more. The increase of ore crushed, which was by the additional tube-mill power, was 42,000 tons, equal to 20%, and would have meant in ordinary times an estimated saving of 1s. per ton, so that the total saving in working costs should have been, but for the war, 3s. 6d. per ton, or a total of £34,000, enough to pay a dividend of over 8%. The ore reserves in 1914 were 660,365 milling tons, averaging 5·49 dwt. per ton, 30,000 milling tons, averaging 5·50 dwt. per ton, and 14,315 milling tons, averaging 4·70 dwt. per ton. In 1918 they were 645,034 milling tons, averaging 5·51 dwt., and 48,909 milling tons, averaging 6·10 dwt. per ton. But as 99,000 tons were eliminated this year, owing to the raising of the pay limit from 4·5 dwt. to 4·8 dwt. per ton, the total had not only been increased, but the value also by a notable amount, although between the two dates they had crushed about a million tons. Of intact reef claim area, at the beginning of the current year, they still had 489 claims on the Main Reef, 547 on the South Reef, and 165 on the Battery Reef, so that there was an ample future for many years if only conditions were made even a little more favourable. An encouraging development had of late taken place on the mine. This was the favourable exploitation of the East Battery Reef, which had been retarded by the terrible floods for several months this year, but was now proceeding smoothly with distinctly satisfactory results, the ore being of somewhat higher grade than in other parts of the mine.

Mr. F. H. Hamilton seconded the resolution, which was carried unanimously.

CHINESE ENGINEERING AND MINING CO., LIMITED.

[illegible]

Business : Operates coal mines in Chih-li, China.

The sixth annual ordinary general meeting of the [illegible] held on December 19 at Winchester House, London, E.C., Mr. W. F. Turner presiding.

[illegible] the notice convening the meeting and the report of the auditors.

The Chairman said : The accounts for the year [illegible] to-day, show a remarkable increase of profit over the preceding year to June 30, 1917, which in its turn had shown a substantial increase over the profit for the year to June 30, 1916. The profit shown in the account is £576,555, while the profit of the preceding year was £291,562 The increase is due to several causes. First, there has been a small increase in the total sales of coal, which amounted to very little short of 3,000,000 tons, the exact figure being 2,996,668 tons. Next, owing to various causes, there has been an increase in the profit per ton, and finally, as is pointed out in the directors' report, the profits have again been materially increased by the rise in the rates of exchange, which continued throughout the year. A [illegible] preceding year, but in order that there may be no misapprehension in the minds of shareholders, we deem it necessary to go into this part of the subject in some detail. The rate of exchange at which our share of the profits of the Kailan Mining Administration for the year ended June 30, 1916, figured in our profit and loss account was 1s. $11\frac{7}{16}$d per dollar. The rate last year at June 30, 1917, was 2s. $5\frac{3}{8}$d per dollar, while the rate this year is 3s. $2\frac{1}{2}$d. per dollar. The significance of these figures cannot escape you. The effect of the rise of the rate of exchange is that our share of the profit of the Kailan Mining Administration, which [illegible] sterling than it would have done at the rate which figured in the accounts of the preceding year. You can make your own calculation as to what the effect would be if our profit for the year had had to be taken into the accounts at the rate of 1s. $11\frac{7}{16}$d., which I have given you for the year ended June 30, 1916, a figure which from our experience may be taken as about the normal one. After adding interest in China, [illegible] to the rapid accumulation of funds, which you will find [illegible] in the balance [illegible] other items, [illegible] account is [illegible] you on [illegible] April last [illegible] in the happier conditions which now prevail, will cease to be made on us. The balance for the year is £576,555. To this there is added the surplus from the preceding year of £202,835, after deduction of the final dividend and also of excess profits duty, making a total credit of £779,390. On the other side you have income tax, which, as you all know, is at the rate of 30%, amounting to £54,023. The next item is reserve for excess profits duty, estimated at £350,000, which compares with £83,810 for the preceding year. This is a somewhat startling figure, but the subject is so familiar, if, indeed, it be not threadbare, that I do propose to dwell upon it. You are aware that the Chancellor of the Exchequer, like his predecessor in office, is under a promise that the excess profits duty shall not be continued after the war. We should therefore be able to count upon its ceasing with the current revenue year ; but it is well to bear in mind that some means will have to be found of replacing it, at any rate to a large extent. The next item is the [illegible] paid on May 15 last, amounting to £50,000. There remains, therefore, the sum of £325,367, which is carried to the balance sheet. Out of this it is proposed that a further dividend of 10% be declared, free of income-tax, making a total of 15%, free of income tax, for the year, which will leave a balance of £225,367.

The balance sheet totals show an increase of over £400,000. There is an increase in the creditors in round figures of about £100,000. This is due almost entirely to dividend and debenture coupons and to debentures drawn for redemption which have not been presented for payment, and this, as we have explained on previous occasions, is due to the conditions brought about by the war. Large numbers of bearer shares and of Kailan bonds are held in Belgium and in the recently occupied parts of France. These areas have consequently been accumulating since the end of the year 1914. Now that these countries have happily been liberated, and when free communication with them has been fully restored, the liabilities will rapidly decrease. We are, indeed, expecting to be able to pay [illegible] s the reserve for excess profits [illegible] liability for the half-year's interest on the debenture issue, £32,400, which became payable on July 1, 1918. The 6% mortgage debenture issue has been reduced by drawings from the original amount [illegible] tures reserve account. The assets show a large increase in the cash and investments. The cash at [illegible] War Loan at cost [illegible] explained on previous occasions that practically the whole of this amount was seized by the Germans during their occupation of Brussels and carried off to Berlin. We are informed by Mr. Cattier, one of our colleagues who has just arrived from Brussels, that the repayment of this amount by the Germans is expected hourly, if it has not already taken place. We shall in due course receive accounts from our bankers, and this item, which has stood in our balance sheet for several years unchanged, will be adjusted. The debtors, £83,885, are about £10,000 less than in the previous balance sheet. There has been a trifling adjustment in the property account, which is increased by £125. The Kailan Administration working capital account shows a small increase at £89,901. The next item, stores taken over by the Kailan Mining Administration, £63,928, is unchanged. The Kailan loan account, which stood at £60,000, has been reduced by £9,856, being our proportion of the cost of the dredging plant, which is represented in the next item of the balance sheet by 9,881 shares in the Chinese Dredger Company, Ltd., costing £9,858. That company owns the dredging plant which is used in the harbour of Chin Wang Tao. Shares in China, £409, are unchanged. The item expenses of underwriting and issue of Kailan bonds has been reduced by £1,725, and now stands at £76,762. It will be admitted, I think, that the balance sheet is a very strong one. If you take the cash and the investments together, amounting in round figures to £1,062,000, and deduct therefrom the whole of the liabilities, which amounted to £740,000, there remains a cash surplus of £332,000, out of which has to be provided the dividend of 10%, which we propose to declare to-day.

As regards the mines which are worked by the Administration, I need only say that development work has been fully maintained during the year, and that the coal in sight at June 30 last is reported as 20,145,000 tons, as compared with 15,960,000 tons at June 30, 1917. There remains only the question of the prospect for the current year. Owing to the absence of Major Nathan on business in Japan, we have not yet received the usual statement of his views on this subject, but the facts which are in our possession enable us to say that while we must not look for a recurrence of the exceptional results with which we have been dealing, the result for the present year must still be a very satisfactory one. The sales during the current year from July 1 down to the present time are not quite equal to those of the corresponding period of the preceding year. The falling off, however, is only 66,000 tons, which is not material, and can be accounted for in various ways. The rate of exchange has continued high during the past four or five months, and it would, therefore, seem that the average rate for our current financial year is likely to be a very favourable one. The Kailan Administration is still working under considerable disadvantage in regard to shipping, our own boats, the "Kaiping" and "Kwangping," being still under requisition to the Government, together with two, if not three, which we held under charter. There has also been, and there is still, considerable difficulty owing to the shortage of rolling stock on the Chinese railways, but Major Nathan has dealt very ably and successfully with both these matters in the past, and now that hostilities in Europe have ceased these difficulties will tend to diminish as time goes on. We consider, therefore, that the prospect for the current year may be regarded with entire satisfaction. I will now move: "That the directors' report and accounts at June 30, 1918, be and they are hereby received and adopted, and that a final dividend be declared of 10%, free of income tax (making 15% for the year, free of income tax), payable on December 20, 1918."

Colonel H. A. Micklem seconded the resolution, which was carried unanimously.

The Chairman next moved the re-election as a director of M. Emile Francqui. M. Francqui, he said, held a very prominent position in the world of finance in Belgium, but it was not possible in present circumstances for him to be with them that day. He took the opportunity, however, of welcoming the Chevalier E. de Wouters and M. Felicien Cattier, who were present at the meeting for the first time after about four years of enforced absence.

Mr. Edmund Davis seconded the resolution, which was carried unanimously.

On the motion of Mr. Edmund Davis, seconded by Colonel Micklem, Mr. W. F. Turner was re-elected a director.

Mr. J. R. Michael proposed the reappointment of Messrs. Annan, Dexter and Co. as auditors.

Mr. A. Caro seconded the motion, which was unanimously agreed to.

On the motion of Mr. Michael, a vote of thanks was accorded the Chairman and directors, and the Chairman having acknowledged the compliment the proceedings terminated.

Professional Directory

AGNEW, John A., Tel. 3700 London Wall.
Mining Engineer,
1, London Wall Buildings, London, E.C.2.

ALDRIDGE, Walter H.,
Mining and Metallurgical Engineer,
c/o Wm. B. Thompson, 14, Wall St., New York.

ARGALL, Philip, & Sons,
Mining and Metallurgical Engineers,
First National Bank Bdg., Denver, Colorado.
Cable: Argall. Code: Bedford McNeill.

ROGERS, MAYER, & BALL. Cable [illegible]
BALL, Sydney H.,
Mining Geologist,
42, Broadway, New York
201, Devonshire Street, Boston.

BEATTY, A. Chester,
25, Broad Street, New York.
No professional work entertained.

BELLINGER, H. C.,
Metallurgical Engineer,
c/o Chile Exploration Co., Chuquicamata
(via Antofagasta), Chile, South America.

BRETT, H. T.,
Metallurgical Engineer,
Falcon Mine, Umvuma, Rhodesia.
Cable: Brett, Umvuma. Usual Codes

Tel.: London Wall [illegible]
BROADBRIDGE, Walter,
Chief Engineer,
Minerals Separation, Ltd., 62, London Wall, E.C.2.
Cable: [illegible] London

BRODIE, Walter M.,
Mining Engineer and Metallurgist,
[illegible], New York.

BROWN, Gilmour E.,
Mining Engineer and Geologist,
[illegible] Rand,
[illegible]

BROWN, R. Gilman, Tel.: London Wall 2770
Mining Engineer,
Pinners Hall, London, E.C.2.
Cable: [illegible] Usual Codes

BURCH, CAETANI, & HERSHEY.
BURCH, Albert,
Consulting Engineer,
Crocker Building, San Francisco.
Cable: Burch. Usual Codes.

BURCH, H. Kenyon,
Consulting Engineer,
Concentrating Department,
Phelps Dodge Corporation,
Warren, Arizona.

BURCH, CAETANI, & HERSHEY
CAETANI, Gelasio,
Consulting Engineer,
Crocker Building, San Francisco.
Cable: Caetani. Usual Codes.

CAMPBELL, Donald F., Tel.: Victoria 2682.
17, Victoria Street, London, S.W.1.
Cable: Mixoist. Code: Bedford McNeill.

CARLYLE, E. J., Code: Bedford McNeill.
Metallurgical Engineer,
c/o British America Nickel Corporation, Ltd.,
Sudbury, Ontario, Canada.

CHANNING, J. Parke,
Mining Engineer,
61, Broadway, New York.
Code: Bedford McNeill.

CLAUDET, F., Limited, Tel.: Central 1100.
Assayers and Samplers,
6, Coleman Street, London, E.C.2.
Cable: Assaying Ave. Usual Codes.

COLE, F. L.,
Mining Engineer,
Shanghai, China.
Cable: Hanco.

COLLBRAN, Arthur H.,
Mining Engineer,
Seoul, Korea.

COLLINS, George E.,
Mining Engineer,
Boston Building, Denver.
Cable: Coleamac. Code: Bedford McNeill

Tel.: London Wall 2778.
COLLINS, Henry F.,
Mining and Metallurgical Engineer,
66, Finsbury Pavement, London, E.C.2.

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.Sc., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone *London Wall 8938.* Telegraphic Address: *Oligoclase* Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago.

SUBSCRIPTION { U. K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XX. LONDON, FEBRUARY, 1919. No. 2.

CONTENTS.

2—3

EDITORIAL

EXPANSION of the activities of East Pool & Agar, Limited, is denoted by the registration of new companies under its control, called Tehidy Minerals, Ltd., and Tolgus Mines, Ltd. Particulars are given elsewhere by our Camborne correspondent. These ventures represent the more hopeful phase of Cornish mining.

MOTOR lorries have been in use in many mining districts for several years, but most engineers have hesitated to employ this mode of transport, fearing that the delicate machinery of the motor would not stand the strain of rough country. The experience of the war has served to remove this shyness to adopt the system, and a wider application of motor transport to mines may be expected in the future. The paper by Mr. J. A. L. Gallard in another part of this issue gives encouragement in this direction.

CO-OPERATION in science and trade is the order of the day. The various societies devoted to technical chemistry have formed a Federal Council, the object of which is to advance and voice the interests of chemical science. The societies represented on this council are the Chemical Society, the Society of Chemical Industry, the Association of British Chemical Manufacturers, the Institute of Chemistry, the Society of Public Analysts, the Faraday Society, the Ceramic Society, the Society of Glass Technology, and the Society of Dyers and Colourists. Similar steps toward solidarity might be taken with advantage by the mining and metallurgical societies, and by the engineering societies.

ROSSITER W. Raymond died suddenly in New York on the last day of 1918. A few years ago, on his retirement from active work, we published a eulogy of his long and beneficent career. We need only say now that he was the last of the older generation of great American mining men; a singularly versatile man, a perfect master of the English language, a poet and preacher, and an authority on mining and metallurgical practice and on mining law. In early days he did much for the *Engineering and Mining Journal*, and as regards his connection with the American Institute of Mining Engineers, it is sufficient to record that "Dr. Raymond" and the "Institute" were interchangeable terms.

BORING for oil in Derbyshire was commenced last autumn, and gradually the number of holes is being increased. Results of the venture should be known in the spring or early summer. The firm of S. Pearson & Son, which is undertaking the work under Government control, has not published its programme or the reports of the American oil engineers on which the campaign is based. The only public discussion on the subject has come from Mr. T. Sington, who has written papers for the *Iron & Coal Trades Review* and for the Manchester Geological & Mining Society. Extracts from these papers are given in the Mining Digest, and we have added a map giving the geology and the place names. Both Mr. Sington and the speakers at the meeting at Manchester are sceptical as to results, but it is not for us to criticize a firm which is willing to spend its own money liberally with a view of proving or disproving a long contested theory.

A Society has been formed under influential auspices called the British Industrial Safety First Association, and since the signing of the Armistice a campaign to inculcate caution among employees has been actively commenced. The employers are now saddled by law with pecuniary responsibilities in connection with accidents, fatal or otherwise, and they naturally provide means for prevention that will satisfy the Home Office regulations and the insurance companies. The employees on their part should take care of themselves, if not as a duty toward their masters, at any rate for their own sake and for the sake of their families and friends. It is right to be careless of life and limb when the Boche invader is to be driven back, but there is no glory in being squashed between an ore-car and the wall of a drive. We hope the mine owners in this country will support the new Association.

THE London Metal Exchange offers facilities for trade and speculation in copper, tin, lead, and zinc, but no business is done in iron and steel, nor does it cater for the manufacturer of and dealer in finished articles. The various sections of the metal trades in London have combined to form an Iron and Steel Exchange. The offices are at 123, Cannon Street, and the secretary is Mr. Cyril Watts. On Tuesdays of each week from 1.30 to 4 p.m. the Exchange will have the use of the Great Hall at Cannon Street Hotel. The objects of the Exchange are wider than merely the provision of a central meeting place for business men. Other objects are the establishment of just and equitable principles of trade, the maintenance of uniformity in rules, regulations, and usages, the adjustment of standards of classification, and, should occasion arise, the settlement of controversies between members. The floor of the Great Hall will be subdivided into eight sections devoted respectively to (*1*) ores, pig, and first steel products; (*2*) sections, bars, rods, wire, etc.; (*3*) sheets and plates; (*4*) structures, tools, and machinery; (*5*) railway material; (*6*) castings and pipes; (*7*) hardware and ironmongery; (*8*) non-ferrous metals, especially aluminium, antimony, copper, lead, nickel, zinc, tin, and copper and brass sheets and tubes.

The Imperial College of Science and Technology.

What is to be the future of the Imperial College of Science and Technology? Days and years go by, and there is plenty of discussion and criticism, but, as Mark Twain said with regard to complaints about the weather, nothing is ever done. The Government Educational Department and those in control of London University cannot agree as to the future of the College. The College is already a "school" of the University, but that distinction affords only certain advantages with regard to examinations for degrees and does not place the College under the control of the University. The desire of the University is to absorb the College and make it an integral part of its constitution. Seeing that some of the courses of study at the Imperial College and the colleges of the University overlap, it may be argued legitimately that absorption and some rearrangement might be beneficial. Others support the absorption by declaring that London, the leading city in the world and the heart of the Empire, should have one great and undivided centre of advanced education, embracing languages, law, medicine, technical science, and other branches of learning. The champions of the Imperial College, on the other hand, desire it to retain a separate entity, and urge that modern technological studies should not be controlled by lawyers, physicians, and professors of the ancient languages, divinity, and music. They demand a free and unfettered growth commensurate with the importance of the application of science to industry, and claim that the College should be given the status of an independent university qualified to grant its own degrees and arrange its own course of studies.

The Imperial College, and the schools from which it was built, have suffered recently from the want of a pertinacious and commanding champion and from the want of a coherent policy. For instance, some of the friends of the Royal School of Mines made the mistake of proposing an entire independence for the School, forgetting that non-ferrous mining is not a big enough industry to afford a curriculum of advanced education in a great variety of collateral subjects. At the present time those in control of the College are so inactive that past and present students have been prompted to take measures to try to induce the governors to make a move. Last month they held a mass meeting at the Union building for the purpose of passing resolutions and obtaining signatures to a petition, calling on the governors to take immediate steps to raise the status of the College to that of an Imperial University of Technology empowered to confer its own degrees. The Royal School of Mines was represented at this meeting by Messrs. E. T. McCarthy and Hugh F. Marriott, who spoke earnestly in favour of the establishment of the university of science independent of the University of London. For our own part we do not think that the objection to becoming part of London University is valid, but whether it is decided to absorb or to erect a new University, it is clear that action to ensure the raising of the College to University status with power to grant degrees should not be postponed any longer. If we have a suggestion to offer, it is that the College, either as an independent University or as part of London University, should acquire the Camborne School of Mines, thus doing double duty by providing means for practical instruction in mining and saving a valuable institution from threatened extinction.

Metallurgical Patent Litigation.

As our readers are doubtless aware, a committee of technical societies is urging a reform of our patent laws. Perhaps the most vital suggestion is that adjudication on validity of patents shall be less in the hands of lawyers than at present. As it is, the arguments and decisions rest entirely with lawyers, who rarely know anything about the subjects involved, and who seek for quibbles in the interpretation of the wordings of specifications rather than plain statements of scientific facts as known at the time of application for the patents.

This is all to the disadvantage of the inventor.

Two cases have been before the courts recently in connection with metallurgical practice in West Australia. These illustrate our contention. One was brought by the owners of the Sulman-Teed bromocyanogen process against the Golden Horse-Shoe company, which had used the process without licence. Mr. Justice McMillan, at Perth, gave a decision entirely in favour of the defendants, holding that the specification was incomplete because no sufficient information was given as to the degree of fineness to which the ore is to be crushed in order to extract the gold, and no warning was given to persons who desired to use the patented process, that the addition of an excess of caustic alkali to the solution is detrimental to the action of bromocyanogen, and that the specification was misleading in its reference to the stability of the halogen compound of cyanogen. An appeal was lodged with the Judicial Committee of the Privy Council. The arguments were heard in November, and judgments were given last month. The judges of this final court endorsed Mr. Justice McMillan's decision. This was not the whole of the case, however, for another, and later, patent was involved, namely, one for the manufacture of bromocyanogen. Mr. Justice McMillan gave a decision against the Golden Horse-Shoe in this part of the litigation, but the Judicial Committee of the Privy Council has reversed the judgment. Thus the owners of the Sulman-Teed patents have eventually lost on both points.

The other case to which we refer is the action brought by the Moore Filter Company against the Great Boulder Proprietary for infringement of the plaintiff's vacuum-filter patent. The judgment has gone in favour of the mine, but details of the decision have not yet arrived in this country. We hope to be able to refer to this matter more fully in our next issue, and we intend also, on another occasion, to review the general proposals of the committee on patent law reform.

Captain J. R. De Lamar.

Captain De Lamar, who died in December in New York, was one of the picturesque figures of American mining. For forty years his name was associated with first one and then another big development enterprise. He always used his own money, and relied on his own judgment. He never sold shares on the public market, but enjoyed a deal with other capitalists. He developed properties and held them as long as a large income was certain, and probably the bulk of his fortune was ma in this way. Born in Amsterdam in 1848, ran away from home at the early age of seve and took to a seafaring life. When 23 yea old, he had obtained his captain's certifica so his title was a genuine one and not assu ed during his connection with mining, as ma people were apt to suppose. When in Ameri shortly after the Civil War he saw an opp tunity for making money by raising sunk ships, and for some years he carried on t business to considerable profit. In 1878 followed the crowd to Leadville, Colora where the celebrated lead-silver deposits h just been discovered. Being a shrewd ma he soon saw that without an intimate kno ledge of mining he and his money would so be parted, so he studied chemistry, met lurgy, assaying, and ore-dressing sufficien to give himself an insight into the proble involved. His first venture was the Terri lead mine in Custer county, which, being low grade, he obtained cheaply. By erecti a concentrator and working on a large sc he made an excellent profit, and in a few yea time he sold the property at a high price. H next scene of operations was in Idaho, wh he bought a group of claims near Silver Ci By running an adit he intersected a numb of lodes at depth and followed them to a dy where an abundance of rich ore averagi 1,000 oz. of silver per ton was found. T he used to ship to the smelters, while the m normal ore averaging $30 per ton was treat in the mill. After extracting ore that ga him a return of a million and a half dollars parted with the mine to the late S. A. Benn and Henry Bratnober, who floated the Lamar Mining Company in London in year 1891. The report issued at the time flotation stated that the average return per from the ore treated in the mill was $18 gold and $13 in silver, while picked ore h yielded a profit of $120,000 for the previo twelve months. The English company pa £125,000 in cash and £205,000 in shares the property. For four years this compa paid good dividends, but later the quality the ore gradually decreased, and the total d tribution amounted to not more than £600,0 on a nominal capital of £400,000. The Ca tain developed an even bigger mine christen after him in Nevada, and this he eventua sold to a New York firm. There was also De Lamar mine in Shasta County, Californ and a De Lamar refinery near New Yo The Mercur gold mine was another of his su cessful ventures, which yielded him a la income for some years. In 1895 he became interested in the deposits now worked by the Utah Copper company, and at one time he had options covering three-quarters of Colonel Wall's shares. The property never appealed to him, however, for he did not see much glamour in low-grade copper ores at a time when the metal was at a low price. In later years he turned his attention to Canada, but his dealings and connections with Nipissing, Dome Mines, and the International Nickel Company are of too recent a date to require record here. In concluding this brief notice of an eventful career we may say that a large part of his fortune has been bequeathed to Harvard, Johns Hopkins, and Columbia as an endowment for medical research in connection with food problems and the prevention of disease.

Government Statistics.

Since the signing of the Armistice and the relaxation of Government control of metals and minerals we have expanded the section of the Magazine devoted to statistics relating to their production and distribution, and to trade reports on the markets and prices. As time goes on and as conditions become settled, we hope to continue to develop this service. In the meantime we offer a number of suggestions to the home and overseas Governments for improvement in the publication of statistics and other information which are collected by them for the benefit of the community. In this issue we have space only for reference to one set of statistics, the Board of Trade Returns relating to imports and exports into and out of this country, and we shall deal with other reports and statistics in a later issue.

The Board of Trade Returns might to advantage be expanded as regards detail. These monthly returns are marvels as regards promptness of issue, and afford an indication of what a government department can do when it tries. To collect figures from every port in the kingdom and issue them in tabular form within ten days of the end of each month is a performance which merits praise. The criticism that we have to make is that the figures give incomplete information relating to the source of the metal and mineral imports. For instance, under the head of copper ore, the returns of the imports during 1918 are as follows: From Spain 43 tons, Chile 491 tons, Cape of Good Hope 234 tons, Australia *nil*, other countries 14,551 tons, total 15,319 tons. That item "other countries," which accounts for over 90% of the total, reminds us of the schoolboy's attempt at a petty cash account, thus: "Received 5s.; expended Church collection Sunday 2d., sundries 4s. 10d., total 5s." Then again the entry of iron and copper pyrites only gives the total 836,703 tons with no classification at all as to source, and the same is the case with manganese ore. With iron ore, out of a total of 6,565,860 tons, the only details are Spanish ore 4,327,114 tons and Spanish manganiferous iron ore 99,886 tons, the remainder being credited to "other countries." In the figures for tin concentrate the entries are: From South America 23,547 tons, British South Africa 5 tons, other countries 8,777 tons, total 32,329 tons. Here again it would be of interest to know something of those "other countries," and in particular the Nigerian figures should be quoted. The figures for metallic copper and lead are analysed with clearness. In the figures for the imports of tin those for the Federated Malay States and Labuan are included with those for the Straits Settlements. Now that the Penang smelter is an important buyer it would be of interest to separate its output from that of the Singapore smelter, but, perhaps, seeing that these figures would not reflect exactly the ultimate source of the tin concentrate, such a segregation would not be of prime importance. The figures for the imports of quicksilver and zinc metal are not classified, and no country of origin is mentioned. In the tables giving the quantities there is an entry "silver ore," but the tonnage is returned as *nil*. In the tables of values, however, there is an entry giving the value of the silver ore imported during the year at £632,726, with a footnote to the effect that "silver ore includes the value of the silver in argentiferous ores and metals imported."

The foregoing metals and metallic minerals are all that are specified by name in the returns, and the tables contain no reference to such important metals as antimony, arsenic, nickel, aluminium, tungsten, chromium, platinum, bismuth, molybdenum, cobalt, or their ores, or of such minerals as corundum, graphite, or mica. In the tables of values, there are items of £4,805,034 representing "other metallic ores," and £5,493,360 representing "other metals and manufactures thereof." These two items presumably cover the many unnamed metals and their ores, and the former includes also the ores of lead and zinc. As for corundum, graphite, and mica, we may suppose that they are included in the tables of value of miscellaneous raw materials. Another mineral product of interest to mining men is petroleum, and the question often arises what amounts of the various grades are imported into Great Britain and from what countries do they come. The Board of Trade Returns classify the imports into kerosene, motor spirit, lubricating oil, gas oil, and fuel oil, but do not give any particulars of country of origin.

It is quite likely that some of the figures for which we call are suppressed at the suggestion of importers who do not want their doings advertised. If so, we hope the embargo will be removed and that the statistics will be published in future in complete and detailed form.

Morrow Campbell on Wolfram.

The deposits at Tavoy, Lower Burma, yield not only important supplies of wolfram, but also plenty of animated discussion as to the geology of lodes. Dr. A. W. G. Bleeck, Mr. E. Maxwell-Lefroy, Mr. H. D. Griffiths, Mr. J. Coggin Brown, and Dr. W. R. Jones have written on the deposits in Burma, and have made many speculative inquiries as to the mode of formation and occurrence and the probabilities for discovery at depth. Now comes Mr. J. Morrow Campbell, a mining geologist well known to our readers as an adept at petrological investigation and analysis. For the last two years he has been in the Tavoy district as a mining engineer engaged in development and prospecting. His opportunities for observation have been great, and he has used them well. He has collected specimens which elucidate many obscure points in connection with the constituent minerals of the lodes and their paragenesis, and he has made a study of the nature of the lodes. From this information he has been able to deduce a theory of the method of deposition of the wolfram and cassiterite, to determine the order of deposition of these two minerals as it bears on their relative continuance in depth, and to provide an explanation of the process of decomposition of wolfram. He touches on these three subjects in his paper published in this issue. Owing to this paper having been prepared as a lecture to be delivered before a mixed audience at Tavoy, it seemed advisable to Mr. Morrow Campbell to embed his new ideas in a groundmass of general information relative to ore deposits suitable to the non-technical section of his audience. We have been loth to eliminate much of the elementary exposition, because the Magazine has many readers who will appreciate the author's clear statement of first principles. At the same time it is desirable to let advanced students know that the paper is worthy of their attention, lest some of them, by a casual glance, should think it is intended only for beginners.

When Mr. Morrow Campbell commenced his researches at Tavoy he was confronted with the fact that the minerals on which the pneumatolytic theory is based are conspicuously absent. This theory was invented to explain the formation of cassiterite, and the theory was cleverly worked out in connection with that mineral. When wolfram began to become of industrial importance, its mode of origin was tacitly assumed to be the same, for the only reason that the two minerals often or usually occur together. At the time of the propounding of the pneumatolytic theory no solvent for cassiterite was known; but on the other hand the presence of minerals containing chlorine, fluorine, and boron suggested the idea that the tin travelled upward from the magma as a gaseous compound which was decomposed on contact with water. Unfortunately for this theory, the Tavoy deposits of wolfram and tin contain practically no chlorides, little fluoride, and never a crystal of the boron mineral, tourmaline. This scarcity of the pneumatolytic minerals led Mr. Morrow Campbell to re-survey our knowledge relating to the origin of ore deposits, and to ransack the archives of modern chemistry in the hope of finding a basis for a new explanation. He naturally first desired to confirm or disprove the old idea that there are no soluble compounds of tungsten. He soon found that there is such a compound as silico-tungstic acid, which, with its alkaline salts, is readily soluble in water. This compound was discovered by Marignac in 1862, and as recently as 1917 Mr. H. W. Hutchin gave particulars of it in a paper read before the Cornish Institute of Engineers. As for tin, a soluble form of stannic acid is known, and moreover tin has undoubtedly been found in mineral springs in the Malay Peninsula. Arguing from these facts Mr. Morrow Campbell holds that highly silicious water under great pressure and at moderate temperature is capable of carrying both tungstic acid and tin in solution, thus providing a new theory of the formation of these deposits.

In discussing the general question of the formation of ore deposits from igneous magmas, the author lays stress on the action of water on the magmas, and its action in bringing certain minerals to the surface after the crystallization of granite and dyke matter, and also its action in creating internal pressure sufficient to cause fissuring. We are not quite convinced that it is necessary for Mr. Morrow Campbell to rely on meteoric water for this action. Mr. W. H. Goodchild, in the series of articles published in this Magazine last year, demonstrated a more convincing cause of the upheavals and fissuring, and he also showed that the amount of available magmatic water was sufficient to carry upward all the mineral filling of fissures. Probably Mr. Goodchild's thesis will cause Mr. Morrow Campbell to modify his view of this phase of the subject.

The third point in Mr. Morrow Campbell's paper relates to the paragenesis of the minerals in the Tavoy veins, particularly as it affects the relative distribution of wolfram and cassiterite in depth. As we recorded in the issue of June last year, Dr. W. R. Jones enunciated a theory that wolfram was deposited at a lower temperature than the cassiterite, so that it would be found at a higher horizon than the tin. In studying the geology of the tin-wolfram deposits ranging from the Southern Shan States through Burma and the Malay Peninsula to the Dutch Indies, he had come to the conclusion that the south-eastern parts had been denuded more than the north-western parts, and that the Malayan deposits corresponding to the deposits on the present surface in Burma had disappeared ages ago. He concluded therefore that tin would be found in the Burma veins at depth, below the wolfram deposits that are now being worked. In his paper printed in the Magazine for June last he drew special attention to a solitary specimen of cassiterite formed on wolfram, and referred to it as a specimen showing the exceptional in nature. Mr. Morrow Campbell has since then made a close study of the mixed wolfram-cassiterite ores found in the Tavoy district, and he finds that Dr. Jones's exceptional specimen was really an example of the rule. Every specimen exhibited by Mr. Morrow Campbell, collected from a number of mines, showed cassiterite following wolfram. Hundreds of his examples showed either cassiterite filling the spaces between wolfram crystals, enclosing wolfram and carrying the impression of its striations, filling cracks in wolfram, or having been actually formed on the surfaces of wolfram. On the other hand he has found no case where tin preceded wolfram, though sometimes the profusion in which well-formed cassiterite crystal faces occur in the mixed ore tends to make the casual observer accept the cassiterite as the older. The weight of evidence adduced by Mr. Morrow Campbell is thus entirely in direct conflict with the theory of Dr. Jones that tin may be found in depth at Tavoy. This is inconvenient for the Tavoy mine owners, but it cannot be helped. As regards this controversy between two able investigators, we may now expect Dr. Jones to publish his theory based on sulphides as carriers, to which he referred in the paper already mentioned.

Mr. Morrow Campbell's paper, as we have said, contains also an account of his investigations in connection with the decomposition of wolfram. This is an unstable mineral, very different in this way from cassiterite. While cassiterite remains unattacked after denudation, wolfram rapidly disappears. Wolfram is readily split along cleavage planes and disintegrates, thus presenting increased surfaces for attack. The iron and manganese in it are in the ferrous and manganous state, and readily let go the tungstic acid to take up more oxygen when the mineral comes in contact with air and water. Alkaline compounds carried in ground-water attack wolfram, combining with the tungstic acid. Sulphuric acid, which has been formed by the oxidation of accompanying pyrite, also attacks wolfram, combining with the iron and manganese, and leaving the tungstic acid free. This latter is usually dissolved by alkaline solutions and carried away, and may subsequently be precipitated once more from solution by contact with acid waters. It will thus be seen that there are many ways in which wolfram may be decomposed and removed. Nor is it necessary to suppose that this decomposition and removal happens only when the outcrop has been weathered into alluvium, for the attack by acid can be effected as readily in the upper parts of the lode wherever oxygenated water can penetrate. This exposition of the mode of disappearance of wolfram is of considerable interest, and may help in the elucidation of problems in connection with ore deposits, where it is desirable that their original constitution should be ascertained and understood.

A conspicuous feature of Mr. Morrow Campbell's method of handling his subject is the logical presentation of his facts and arguments. There is never any doubt as to his meaning. He is also a hard hitter, going for his opponents without gloves. But this is a characteristic of discussions at such places as Tavoy and Ipoh, where there are no official stenographers to take record of the proceedings and no publication committees to circulate the reports. The hurlings of chunks of old red sandstone are, however, always intended and accepted in the Pickwickian sense.

REVIEW OF MINING

Introduction.—The Peace Conference has been sitting for some time and the results appear to be satisfactory for an eventual international understanding. At home there are many labour troubles and promises of more. As far as mining is concerned, the fall in the price of metals from the war basis is creating anxiety. The cessation of demand for copper and the unlikelihood of any resumption of shipments to Germany in the near future have caused a great restriction of output in the United States and a general lowering of wages. In this country the great accumulation of Government stocks of lead is giving trouble. Cornishmen are attempting to obtain some financial aid or similar assistance from the Government, but judging by the treatment of the lead and zinc mines such complaisance is hardly to be expected.

Transvaal.—The value of the gold produced in the Transvaal during 1918 was £35,768,688, as compared with £38,323,921 in 1917 and £39,484,934 in 1916. The native-labour position at the mines has not improved, and the figures given in the statistical table in another part of the Magazine show a continued decline. In many quarters recruiting has stopped for the time, so that the immediate outlook is not bright.

The Government Areas has developed in a notable manner during the year 1918. The reserve on December 31 was estimated at 9,445,000 tons averaging 8 dwt., as compared with 7,016,000 tons averaging 7·5 dwt. a year ago. Another Barnato company, the Van Ryn Deep, shows an important increase, the figures being 2,445,759 tons averaging 9 dwt., as compared with 2,258,598 tons averaging 8 dwt. As regards Government Areas, the reserve is about equal to that at New Modderfontein, which is usually considered at present the greatest gold mine of the Rand. The success of Government Areas is all the more welcome seeing that the property was acquired without any preliminary bore-hole evidence, and that the results during the first few years were far from brilliant.

The dispute as to the control of the Witwatersrand Deep continues. The present bone of contention is the voting power of the enemy shares. The local shareholders' association protests against the Central Mining & Investment Corporation using these shares in its own favour, and considers that the corporation exercised undue influence on the Public Custodian in obtaining his vote on th shares. An appeal is now being made to th British and Union Governments to preven the vote on the shares being used in this wa

At the meeting of Modderfontein East, th chairman gave figures for the results of de velopment up to the end of November. Th ore proved amounts to 350,450 tons averagin 7·3 dwt. over 57 in. These results have bee obtained between No. 1 (Cloverfield) shaft an the Geduld boundary. No. 3 shaft, in th northern part of the newly leased section, i down 818 ft. Here a dyke has been encoun tered, and the continuation of the reef wa sought by diamond-drilling. In mid-Decem ber the reef was discovered at a distance o 55 ft. from the bottom of the shaft. At bot No. 1 and No. 3 shafts water troubles hav been considerable. Further funds will b required for development, and these are bein provided by the Central Mining & Investmen Corporation. The Rand Klip area is not be ing touched at present.

Simmer Deep is one of the unsuccessfu mines of the Rand. No dividend has eve been paid; the share capital is £1,650,00 and there are £492,800 first debentures an £212,500 second debentures. Last Septem ber we recorded that the first debenture hold ers had agreed to suspend redemption for fiv years, and that the second debenture holder had been obliged to forgo both interest an redemption. It is now announced that furthe capital is required in order to meet expense pending the expected reduction of costs an increase of labour supply. It has been de cided therefore to raise funds by the issue o prior lien stock, and the Consolidated Gol Fields has undertaken to underwrite £100,00 provided the whole of the profits be devote to the payment of interest on the stock an the first debentures and to the redemption o the stock.

In the north-west corner of Daggafontei Farm, in the Far East Rand, are two proper ties, belonging to the Clydesdale and Cassel coa companies respectively. The two propertie used to belong to the first named, but th northern half was leased, and finally sold, t the latter. Both companies opened the coa deposits on their land, but these were exhaus ted some years ago, and they acquired othe coal areas, and thereafter their assets at Dagga fontein consisted mainly of the gold-minin rights. The two companies are now amal gamating these rights, and are handing them over to a new company, to be called the Cassel Clydesdale (Springs) Gold Mines, Ltd. They are also approaching the Government with the object of asking for additional adjoining land on a gold-mining lease, in order to obtain a sufficiently large area to warrant the expenditure of capital on the scale required for opening mines in the Far East Rand. Sir Abe Bailey is acting with the companies in this matter, and will provide most of the funds required. The Cassel company is in the Lace control, which owns the Vlakfontein and Spaarwater farms in the Far East Rand. Last September we mentioned that a scheme was on foot for the development of these properties, here again the money to be provided by Sir Abe Bailey.

We have already recorded that the Messina company was not allowed to ship copper matte and ore to England after February last year or to the United States after the beginning of June. It is not surprising, therefore, to find that for the year ended June 30 last the working profit was only £25,174, and that after paying debenture interest and allowing for debenture redemption there was an adverse balance of £22,917. We shall refer to the prospects of this company in our next issue, after the meeting of shareholders has been held.

Rhodesia.—The mineral output of Southern Rhodesia during 1918 is given in the table below, together with the corresponding figures for 1917 for purposes of comparison.

		1917	1918
Gold	£	3,495,391	2,652,250
Silver	oz.	211,939	175,722
Copper	tons	3,911	3,253
Chrome	,,	72,962	31,285
Asbestos	,,	9,562	8,574
Coal	,,	548,954	491,268
Wolfram	,,	11	11
Scheelite	,,	—	26
Arsenic	,,	—	113
Antimony	,,	15	15
Barytes	,,	—	54
Ironstone	,,	5,290	6,552
Diamonds, carats		619	450

The following table gives a record of the dividends paid by Rhodesian mining companies during 1918:

	Rate declared or its equivalent subject to income tax.	Amount distributed
	%	£
Eldorado Banket	15	45,000
Falcon Mine	20	80,000
Gaika Gold Mining	5	13,675
Globe and Phoenix	82.8	165,614
Kimberley (Mashonaland)	1⅓	4,000
King (Asbestos) Rhodesia	7½	9,567
Lonely Reef	30	81,302
Rezende Mines	20	23,687
Rhodesia Chrome Mines	10	6,000
Rhodesian and General Asbestos	5	20,000
Shamva Mines	15	90,000
Wankie Colliery	15	76,995
Total		£615,640

The foregoing table does not include small local companies or syndicates.

The output of gold during December was worth £192,870, as compared with £145,458 in November and £270,616 in December, 1917. The total output during 1918 was worth £2,652,250, as compared with £3,495,391 in 1917 and £3,895,311 in 1916. The fall during 1918 is due to war conditions, to floods in February, and particularly during the last three months of the year to the influenza epidemic.

West Africa.—The yield of gold during December was returned at £112,621, as compared with £108,796 in November, £122,602 in December, 1917, and £146,409 in December, 1916. The total output for 1918 was £1,333,553, as compared with £1,529,977 in 1917 and £1,615,306 in 1916.

The output of gold in December by the Ashanti Goldfields was £32,342, as compared with £37,366 in November and £17,730 in October. The November figures were normal, and those for October reflected the ravages of influenza. The low December figure is due to poor health among the European underground staff, coming as an after effect of the epidemic. The staff is now being reinforced.

Nigeria.—The output during 1918 of Nigerian tin companies reporting in the London market amounted to 6,648 tons of concentrate, as compared with 6,927 tons in 1917 and 6,594 tons in 1916. These figures do not include the yields of the mines of the Niger Company or of mines worked privately.

Australasia.—The Queensland Government and Legislature have given the debenture holders of the Chillagoe Railway and Mines company plenty of trouble in connection with the acquisition of the property by the State. Two years ago the Premier offered £450,000 in cash, but the Legislature refused to confirm the deal. Subsequently a new agreement provided for £475,000 State bonds as the purchase price. Again the Legislature rejected the proposal. Last month the debenture holders received another offer providing for the issue of State bonds, but making the interest start with January 1, 1919, thus robbing the holders of two years' interest. Moreover there is a stipulation that the vendor company must prove a good title to the whole of the properties. It is quite possible that some of the older properties may be defective in title, so the State has a loophole for backing out of the whole agreement if there is the least doubt as to the validity of the smallest fraction of the property. Some of the debenture holders advised that the State offer should be rejected, and additional capital raised so that the mines and railway could be worked once more by the company. The majority, however, have decided to accept the State's offer.

An influenza epidemic has made its appearance at various places in Australia. So far as reports go, the chief cities only appear to be attacked, and no word has yet come through with regard to the mining districts.

The Australian Gold Producers' Committee is petitioning the Federal and State Governments for a number of concessions and other means of assistance to the languishing gold-mining industry. Among the demands are the removal of all taxation, the admission of supplies duty-free, the payment of substantial rewards for the discovery of new goldfields, and the construction of dams and the sinking of wells and bores out of public money. It is also proposed to ask the Repatriation Department to subsidize prospecting parties composed of returned soldiers.

The Sulphide Corporation has a plan in hand for producing sulphate of potash from alunite found near Port Vincent, on Yorke's Peninsula, South Australia. At two places there are outcrops of alunite on the cliff faces, and under these circumstances it has been easy to prove the existence of 1,000,000 tons of the mineral. The deposits have been described by Mr. R. Lockhart Jack, the Assistant Government Geologist. The alunite will be shipped to the corporation's works at Cockle Creek for treatment.

In our last issue, our Kalgoorlie correspondent gave particulars of a venture for establishing a soda industry in West Australia. Since then details have come to hand of a similar proposal for the development of salt deposits on Casuarina island at the mouth of the Fitzroy river. This is not far from Mount Morgan. Bores on the island show the presence of two beds of gravel and sand containing brine, which rises in the bores to within 20 ft. of the surface. Coal and limestone, the other two raw materials required in the ammonia-soda process, are plentiful locally. There seems to be some fear expressed that the hot climate will be antagonistic to the working of this process. One of Brunner, Mond & Co's. engineers has recently visited the island.

The report of the Associated Northern Blocks for the year ended September 30 last shows that at the old mine at Kalgoorlie the tributers continue to extract ore of good quality, 16,285 tons being treated for a yield of gold worth £70,794, of which £16,089 accrued to the company as royalty. At the Gimlet leases at Ora Banda, the mill was closed from May, 1917, to the beginning of January, 1918, while work was concentrated on development. From the beginning of January to the end of the period under review, 15,850 tons of sulphide ore yielded £32,832. The net profit of the company from all operations was £4,425, so it will be seen that if it had not been for the tributers' work at Kalgoorlie the company would have had a considerable debit balance for the year. The result of development at the Gimlet leases has not been encouraging, as the profitable ore occurs only in patches.

The cost of water at Kalgoorlie is necessarily high, owing to the supply being pumped from Mandaring, 300 miles away, and at an altitude 1,200 ft. lower. As Mr. T. B. Stevens mentioned in a paper quoted in our issue of March, 1918, the charge for treatment water is 7s. per 1,000 gallons, and 1s. 6d. for sluicing water. With the rise of costs at Kalgoorlie, efforts have recently been made to secure a reduction in the price of water. Unfortunately the Government is of opinion that it is impossible to grant any rebate from present prices, as the supply is already sold at a loss. The loss for the past year has been no less than £120,000. Under these conditions the mines are already in fact receiving a subsidy out of public money. Possibly the prices might be lowered if the gold-mining position became acute and a reduction could save the situation, but the price of water is not likely to be the decisive factor.

India.—The output of gold during 1918 is returned at 485,236 oz., as compared with 520,382 oz. in 1917, 541,077 oz. in 1916, and 556,596 oz. in 1915. The decrease is due to the lower assay-values in depth.

Influenza has interfered with mining operations in Lower Burma, as is evidenced by the reduction in the output at some of the wolfram mines. At the Kanbauk the yield in December was 33¼ tons, as compared with 45¾ tons in December, 1917. The total yield for 1918 was 376½ tons, as compared with 357 tons in 1917. The hydro-electric installation has been working and is doing well. Mr. H. D. Griffiths gave some account of this installation in our issue of November, 1917.

Malaya.—The report of the Pahang Consolidated for the year ended July 31 last shows an apparent fall in the tin content of the ore, 1,993 tons of tin concentrate being extracted from 187,300 tons of ore, as compared with 2,656 tons from 156,700 tons the year before. The explanation is that opportunity was taken during the period of high prices of the metal to treat comparatively large amounts of weathered low-grade ore from open-cuts. Development underground has more than maintained the reserve, which now stands at 600,000 tons, and this in spite of the fact that development in depth was suspended owing to the impossibility of obtaining the necessary additional pumps.

Canada.—The negotiations in connection with the absorption by the Kirkland Lake Proprietary of the properties of the Tough-Oakes, Burnside, and Sylvanite companies, the Sudbury Syndicate, and a company at Cobalt have been concluded and the terms provisionally agreed. The final adoption of the scheme is subject to the confirmation of the respective valuations by Lt.-Col. H. H. Johnson, consulting engineer to the Kirkland Lake Proprietary, who is now on the spot.

United States.— The preliminary estimate of the output of gold during 1918 is $68,493,500, or $15,257,200 less than in 1917. California headed the states with $17,207,000, Colorado was second with $12,853,500, and Alaska was third with $9,108,500. The output of silver was 67,879,206 oz., as compared with 71,740,362 oz. in 1917. Of the various states, Montana was first with 15,341,793 oz., Utah second with 13,439,811, Idaho third with 10,138,056, and Nevada fourth with 10,113,405. The Montana output came chiefly from the copper mines, that from Utah from copper and lead mines, that from Idaho from lead mines, and that from Nevada from gold-silver mines.

The output of copper from United States mines during 1918 is estimated at 834,800 tons, as compared with 843,030 tons in 1917 and 867,310 tons in 1916. The output of quicksilver was 33,432 flasks, as compared with 36,159 flasks in 1917.

The Committee appointed by the Secretary of the Interior to inquire into the status of gold mining has issued a report. Like the Inchcape committee in this country, it does not believe in bonuses on gold production, at any rate at present. It agrees that the cost of mining gold has gone up and that the value of gold as a purchasing agent has diminished, and admits that these conditions have had a serious effect in causing a decline in the output. On the other hand the report shows that the United States has a bigger gold reserve than it knows what to do with. The total reserve is over 600 million pounds, this high figure being due to the influx of gold from other countries caused by the United States becoming a creditor instead of a debtor country. The committee is in favour of gold mines being free from the excess profits tax.

We have referred on several occasions to the Alaska-Juneau Company's big low-grade gold mine, which has proved a failure so far. It is now announced that new bonds representing $1,500,000 are to be issued to meet outstanding obligations and floating debt, and that bonds for $500,000 are to be offered for sale at par to provide capital for modifications in the milling plant. Mr. F. W. Bradley estimates that with this expenditure it will be possible to increase the milling capacity to 8,000 tons per day, and thereby earn a working profit in normal times of $1,400,000 per year. During the year 1918, the monthly returns varied widely, but the figures for the first ten months showed a total of 498,861 tons milled of an average assay-value of 86½ cents per ton, a yield of $376,707, or 68¾ cents per ton, and a working cost of $314,282, or 63 cents per ton. This cost does not include administration and general expenses. When the mine was first started the estimated output was the figure now quoted, 8,000 tons per day, but owing to methods and machinery being adopted that had not been previously tried, the rate of output was far less than expected.

Further cables from the Camp Bird mine show that, at the point in the tunnel workings where it was intended to rise to the old workings for the purpose of ventilation, the developments are promising, and it is intended to continue development here instead of rising. At another point the lode is wide, averaging $12 mostly in silver.

The application of powdered coal as fuel is spreading rapidly in America. The Garred-Cavers Corporation has been formed in New York to introduce the Garred and Cavers patent processes by which pulverized coal is used in blast-furnaces. The process is to be used at the Tennessee Copper Co's. plant, and at the International Nickel Co's. smelter near Sudbury, Ontario. Mr. Garred is an Anaconda man, and he helped to build the new smelting plant at Mount Morgan.

Mexico.—The Esperanza company, operating at El Oro, reports that an option on a new property of mineral and agricultural value on the west coast of Mexico has been arranged. An examination is to be made of the property.

THE ORE MINERALS OF TAVOY

By J. MORROW CAMPBELL, B.Sc., M.Inst.M.M., F.R.G.S.

The author delivered a lecture at Tavoy, Lower Burma, last year, giving his views on the origin of the wolfram deposits. As the lecture contains much novel matter we reproduce it in full herewith, and we refer to it in the Editorial columns.

The subject will be treated under the following heads:

1. Conditions of occurrence.
2. Source and method of segregation.
3. The origin of veins and how they are filled.
4. The order in which minerals developed in veins.
5. Notes on various minerals.
6. The decomposition of wolfram.

I shall consider wolfram and cassiterite most in detail, but shall touch on scheelite, molybdenite, bismuth, chalybite, chalcopyrite, pyrrhotite, pyrite, galena, blende, and magnetite, as well as secondary minerals derived from the foregoing. I shall leave practically out of consideration fragmental material, confining attention to those occurrences in which the ores are essentially in the position in which they were originally deposited.

CONDITIONS OF OCCURRENCE.—The outstanding characteristic is that Tavoy ores are always found in the vicinity of the contact of the granite with the overlying sedimentary rocks. They may be found in either or in both, but never at any great distance above or below the contact. In many parts of the district I have observed, as original constituents of the granite, wolfram alone, cassiterite alone, and also both together in varying ratios, sometimes accompanied by bismuthite. Such occurrences are always near the surface of the granite, never deep down within its mass, and also never far removed from wolfram or tin-bearing veins. Why should wolfram and cassiterite—minerals of nearly three times the density of granite—be found at the surface of the solidified magma and not exist to any appreciable extent in it lower down? In several places I have observed aplite dykes (aplite is merely a variety of granite) which contain wolfram and cassiterite in appreciable quantities. Such occurrences are invariably in the vicinity of wolfram-bearing veins.

We next come to greisen which carries cassiterite and wolfram as well as various sulphides in very considerable quantities, sometimes exceeding 10%. Greisen occurs as bands varying greatly in width on the walls of veins in granite. Greisen is merely granite altered in situ by the conversion of its felspar into mica. This change involves the removal of half the silica from felspar and the addition of water. It is a change which involves loss in weight, hence greisens are often porous rocks. The same agents which brought about this change, often, but not by any means always, filled part of the vacant space with crystals of ore minerals and brought about other changes of less importance. Greisen usually occurs in wolfram and tin-bearing areas only.

It is hardly possible to imagine geological and physical conditions more suitable than those in the Tavoy district for the study of vein formation and filling, especially with reference to tin and wolfram. I have not seen any other district in any part of the world that can compare with Tavoy as a field for this study.

No thinking man can doubt that wolfram, tin, etc., were brought up toward the surface by the molten granite. No theory of lateral secretion will hold for a moment in the case of wolfram or tin.

A vein is the result of the introduction into an open space in a rock of material different in composition from that of the enclosing rock. Veins do not necessarily contain mineral of commercial value. The veins in Tavoy are merely cracks or fissures in the granite or sedimentary rocks filled with quartz, with or without felspar or mica, throughout which valuable minerals may be distributed in a more or less erratic manner. Broadly speaking the most marked peculiarity of the veins is that they usually occur in groups parallel and close to one another, often very numerous, very narrow, and frequently of short length. We often find a second parallel series intersecting the first. Such deposits usually end abruptly along the strike, the ground outside not having been fissured or cracked.

The longest vein in the district extends for several miles northward from the vicinity of Yewaing. It strikes about N10°W-S10°E practically parallel to the axis of the granite ridge. It is certainly one of the oldest veins in the district, has undergone several re-openings, and contains wolfram, iron, copper, lead, and zinc. In cases where veins cross one another, those striking more nearly N and S are, generally speaking, older than those whose strike approaches more nearly E and W. In general the wolfram-bearing veins of the district appear to strike W of N and E of S, but they vary very greatly.

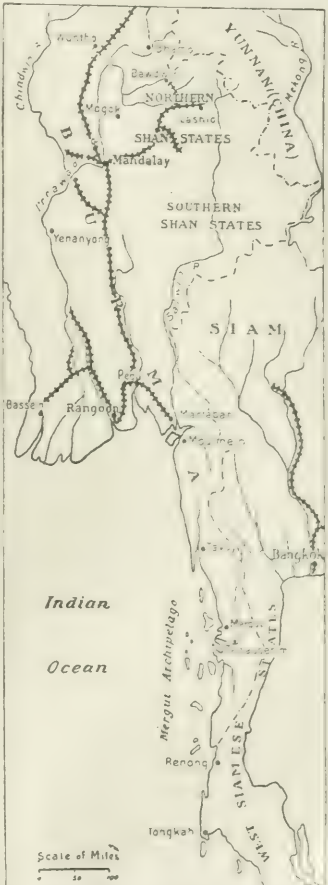
When a number of parallel veins occur close to one another, wolfram or tin is usually present in greater or less quantity in them; in other words, fissuring in or above the granite almost invariably means mineralization. This leads us to suspect that there may be a close connection between the cause of segregation of ore minerals from the magma and the agency which produced fissuring.

Another characteristic of many Tavoy veins is that they diminish in both width and values as they go downward.

SOURCE AND METHOD OF SEGREGATION.—Down below the sedimentary strata of the earth's crust large volumes of rock are known to assume the liquid condition. When such molten rock forces its way to the surface and cools there it is called volcanic rock. When it has not sufficient energy to force an opening to the surface but comes part of the way, often insinuating itself in considerable masses along the bedding planes of the sedimentary rocks, and there cools, it is called igneous rock. Endowed with still less energy, it may merely raise the superincumbent strata over a certain area, bursting them apart to a limited extent perhaps, and cool below a considerable overburden and therefore under great pressure. This gives us another variety of igneous rock. The whole mass is called a batholith, and previous to its solidification it was a magma. In the Tavoy district we have three such batholiths exposed parallel to one another in the form of ridges whose axes lie a little West of North and East of South.

Regarding the composition of the magma of Tavoy granite, we have no accurate knowledge. We must assume it to have been in the liquid condition and for such a period as to have permitted the well known laws governing solutions to have done their work. It is safe to say that the granite magma was a liquid composed largely of silica with smaller quantities of alumina, alkaline oxides, magnesia, lime, ferrous and manganous oxides, also traces of tungsten, tin, and some rarer metals. Sulphur and carbon were also present, as well as fluorine, boron, etc. One of the most important constituents, however, was water, and it was present in more considerable quantity than one might at first be inclined to associate with the idea of molten rock. The very existence of the magma as such may depend upon its containing water.

Laboratory experiments conducted with the object of elucidating the mysteries of magmas have signally failed in two directions. Pressures such as those in nature are impracticable



MAP OF BURMA

and time is too short; nature is not in a hurry. The lifetime of one individual might be too short a time in which to conduct one series of adequate experiments on magmatic cooling, even if the at present insuperable obstacle of pressure were overcome. Our hopes of defi-

THE ORE MINERALS OF TAVOY

By J. MORROW CAMPBELL, B.Sc., M.Inst.M.M., F.R.G.S.

The author delivered a lecture at Tavoy, Lower Burma, last year, giving his views on the origin of the wolfram deposits. As the lecture contains much novel matter we reproduce it in full herewith, and we refer to it in the Editorial columns.

The subject will be treated under the following heads:

1. Conditions of occurrence.
2. Source and method of segregation.
3. The origin of veins and how they are filled.
4. The order in which minerals developed in veins.
5. Notes on various minerals.
6. The decomposition of wolfram.

I shall consider wolfram and cassiterite most in detail, but shall touch on scheelite, molybdenite, bismuth, chalybite, chalcopyrite, pyrrhotite, pyrite, galena, blende, and magnetite, as well as secondary minerals derived from the foregoing. I shall leave practically out of consideration fragmental material, confining attention to those occurrences in which the ores are essentially in the position in which they were originally deposited.

CONDITIONS OF OCCURRENCE.—The outstanding characteristic is that Tavoy ores are always found in the vicinity of the contact of the granite with the overlying sedimentary rocks. They may be found in either or in both, but never at any great distance above or below the contact. In many parts of the district I have observed, as original constituents of the granite, wolfram alone, cassiterite alone, and also both together in varying ratios, sometimes accompanied by bismuthite. Such occurrences are always near the surface of the granite, never deep down within its mass, and also never far removed from wolfram or tin-bearing veins. Why should wolfram and cassiterite—minerals of nearly three times the density of granite—be found at the surface of the solidified magma and not exist to any appreciable extent in it lower down? In several places I have observed aplite dykes (aplite is merely a variety of granite) which contain wolfram and cassiterite in appreciable quantities. Such occurrences are invariably in the vicinity of wolfram-bearing veins.

We next come to greisen which carries cassiterite and wolfram as well as various sulphides in very considerable quantities, sometimes exceeding 10%. Greisen occurs as bands varying greatly in width on the walls of veins in granite. Greisen is merely granite altered in situ by the conversion of its felspar into mica. This change involves the removal of half the silica from felspar and the addition of water. It is a change which involves loss in weight, hence greisens are often porous rocks. The same agents which brought about this change, often, but not by any means always, filled part of the vacant space with crystals of ore minerals and brought about other changes of less importance. Greisen usually occurs in wolfram and tin-bearing areas only.

It is hardly possible to imagine geological and physical conditions more suitable than those in the Tavoy district for the study of vein formation and filling, especially with reference to tin and wolfram. I have not seen any other district in any part of the world that can compare with Tavoy as a field for this study.

No thinking man can doubt that wolfram, tin, etc., were brought up toward the surface by the molten granite. No theory of lateral secretion will hold for a moment in the case of wolfram or tin.

A vein is the result of the introduction into an open space in a rock of material different in composition from that of the enclosing rock. Veins do not necessarily contain mineral of commercial value. The veins in Tavoy are merely cracks or fissures in the granite or sedimentary rocks filled with quartz, with or without felspar or mica, throughout which valuable minerals may be distributed in a more or less erratic manner. Broadly speaking the most marked peculiarity of the veins is that they usually occur in groups parallel and close to one another, often very numerous, very narrow, and frequently of short length. We often find a second parallel series intersecting the first. Such deposits usually end abruptly along the strike, the ground outside not having been fissured or cracked.

The longest vein in the district extends for several miles northward from the vicinity of Yewaing. It strikes about N10°W - S10°E practically parallel to the axis of the granite ridge. It is certainly one of the oldest veins in the district, has undergone several re-openings, and contains wolfram, iron, copper, lead, and zinc. In cases where veins cross one another, those striking more nearly N and S are, generally speaking, older than those whose strike approaches more nearly E and W. In general the wolfram-bearing veins of the district appear to strike W of N and E of S, but they vary very greatly.

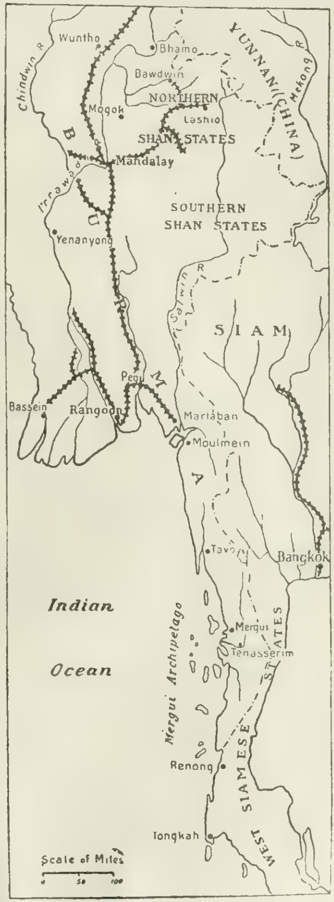
When a number of parallel veins occur close to one another, wolfram or tin is usually present in greater or less quantity in them; in other words, fissuring in or above the granite almost invariably means mineralization. This leads us to suspect that there may be a close connection between the cause of segregation of ore minerals from the magma and the agency which produced fissuring.

Another characteristic of many Tavoy veins is that they diminish in both width and values as they go downward.

Source and Method of Segregation.—Down below the sedimentary strata of the earth's crust large volumes of rock are known to assume the liquid condition. When such molten rock forces its way to the surface and cools there it is called volcanic rock. When it has not sufficient energy to force an opening to the surface but comes part of the way, often insinuating itself in considerable masses along the bedding planes of the sedimentary rocks, and there cools, it is called igneous rock. Endowed with still less energy, it may merely raise the superincumbent strata over a certain area, bursting them apart to a limited extent perhaps, and cool below a considerable overburden and therefore under great pressure. This gives us another variety of igneous rock. The whole mass is called a batholith, and previous to its solidification it was a magma. In the Tavoy district we have three such batholiths exposed parallel to one another in the form of ridges whose axes lie a little West of North and East of South.

Regarding the composition of the magma of Tavoy granite, we have no accurate knowledge. We must assume it to have been in the liquid condition and for such a period as to have permitted the well known laws governing solutions to have done their work. It is safe to say that the granite magma was a liquid composed largely of silica with smaller quantities of alumina, alkaline oxides, magnesia, lime, ferrous and manganous oxides, also traces of tungsten, tin, and some rarer metals. Sulphur and carbon were also present, as well as fluorine, boron, etc. One of the most important constituents, however, was water, and it was present in more considerable quantity than one might at first be inclined to associate with the idea of molten rock. The very existence of the magma as such may depend upon its containing water.

Laboratory experiments conducted with the object of elucidating the mysteries of magmas have signally failed in two directions. Pressures such as those in nature are impracticable



Map of Burma.

and time is too short; nature is not in a hurry. The lifetime of one individual might be too short a time in which to conduct one series of adequate experiments on magmatic cooling, even if the at present insuperable obstacle of pressure were overcome. Our hopes of defilying strata were burst upward and the pressure thus relieved. This fracturing could take place only immediately above the liquid aqueous part of the magma, and thus the origin of the numerous parallel veins is accounted for in circumscribed areas.

Relief of pressure would result in partial solidification; increase of pressure resultant on further absorption of water would cause re-solution of separated solids, and ultimately either re-opening of the first series of fissures or the formation of a new series. The events I describe extended over considerable periods of time. Even the fracturing was a slow operation.

The failure of unusually accepted ideas has led me to put forward this theory in the belief that it explains rationally all the phenomena of wolfram and tin occurrence in Tavoy. Unless some leaching process such as I describe was operative just before solidification of the granite magma, and one which brought the ore minerals from below upward, how can we explain the existence, near the surface of the granite, of a layer, in some places proved to be over 50 ft. thick, in which cassiterite and wolfram occur uniformly distributed throughout the rock? Such occurrences are not uncommon. The rock often weathers rapidly and may be worked by ordinary ground sluicing. I know considerable areas worth between 1 and 2 lb. per cubic yard.

The origin of the water which brought up the ore minerals in solutions must be sought. In many parts of the world hot water in enormous quantities issues from the ground; the geysers of Iceland and New Zealand are conspicuous examples. We cannot believe that these vast quantities of water are being given off century after century by molten rock. It has been urged that meteoric water does not pass down to great depths, because deep mines and bore-holes are almost invariably dry below the first few hundred feet. We shall not contend that surface water is passing down everywhere to great depths. It must be borne in mind that hot springs occur invariably in localities where the upper strata have been fractured by igneous rock thrust upward. Such fractured strata are much more likely to permit water to pass down than would undisturbed strata. Though we have no actual proof that meteoric water does pass down to great depths, the evidence of hot springs and other natural phenomena involving the presence of large volumes of water underground compel a great many people to assume that surface water does pass down to great depths in fractured strata. The upheavals caused by Tavoy granite resulted in extensive fracturing of the overlying sedimentary rocks, and we are justified in believing that by this means water gained access to the molten magma at many points. There is evidence in the numerous hot springs of the district that surface water is still passing down and being forced up. Such phenomena as we see them to-day are but remnants of an activity that was much greater in past times.

We will now inquire how tin and tungsten are transported in nature. It is only within the last few years that any interest has been displayed regarding wolfram, and even now no information regarding its origin is to be obtained from books. Certain theories were put forward by Elie de Beaumont and Daubrée about 70 years ago regarding the origin of cassiterite in veins. They were the result of laboratory experiments, the whole value of which depends upon whether water was or was not in gaseous condition at the points in veins where cassiterite was being deposited. Since cassiterite certainly travels in the fluid condition to veins, and since there was no known solvent to carry it in the liquid condition, the ingenious theory that it travelled as a gas (fluoride or chloride) was devised, and plausibility was lent by the fact that these vapours are decomposed by water, yielding the oxide. This was proved to be true in the laboratory. This theory has been accepted ever since and the name pneumatolysis was coined to indicate all such processes in nature. As long as chlorine, fluorine, and boron compounds accompanied cassiterite in the veins in adequate quantity the theory was quite credible, but what are we to do now that Tavoy veins show practically no chlorides, little fluoride, and never a crystal of tourmaline?

A theory based on laboratory experiments with tin gave birth to pneumatolysis, and promptly wolfram, scheelite, and other associates of tin were credited with a similar origin. Let us take the case of wolfram. I can see no evidence whatver of pneumatolytic origin but much evidence of aqueous origin. Wolfram was certainly in solution in the granite magma at its surface. We cannot ascribe its presence there, uniformly distributed, to pneumatolysis, nor is it credible that water in the magma was in the gaseous condition at the time the wolfram was imprisoned within it. The same argument applies to cassiterite when occurring as a primary constituent of granite.

Our past ignorance of a form in which tin could be transported in aqueous solution so as to deposit cassiterite in a vein is no proof that such does not exist.

Lindgren, writing in 1901 on "Metasomatic Processes in Fissure Veins," says that "tin may be held in solution and deposited at ordinary pressures by thermal waters." He quotes Prof. Winkler as showing that tin exists in granites and other acidic rocks in some cases not as cassiterite but chemically combined in silicates partly replacing silica; and he quotes also Verbeck, who refers to a hot spring in Malacca which deposits silicious sinter containing, according to an analysis by St. Meunier, 91·8% SiO_2, 0·5% SnO_2, 0·2% Fe_2O_3, and 7·5% H_2O. If hot silicious spring water at the surface deposits solids containing 0·5% cassiterite, how much more capable would similar silicious water be, at higher temperature and pressure, of transporting cassiterite from magma to veins.

The case of tungsten is even simpler than that of tin. Few know of the existence of a compound called silicotungstic acid; its formula is $SiO_2, 4H_2O, 12WO_3$. Silica is ordinarily insoluble in water, so also is tungstic oxide; yet 5 parts of silica when combined with 6 parts of water and 232 parts of tungstic oxide yield this substance, which is freely soluble in water and not decomposed by dry heat till over 350°C. The alkaline silicotungstates are also readily soluble in water.

I believe that highly silicious water under high pressure and at moderate temperatures is capable of carrying both tungsten and tin in solution, that this is the agent which extracts them from the granite magma and transports them to veins, and that they do not pass upward in gaseous form.

The same liquid appears to dissolve and leach fluorite and other minerals from the magma. Fluorite crystals develop in veins, not simultaneously with wolfram or cassiterite, but at a later stage, that is to say, a lower temperature.

It is not credible that consolidation of the granite magma took place above the critical temperature of water. If it took place below that temperature, how could cassiterite and wolfram escape entanglement in it? If they went out in the acid mother-liquor, they must have been in the liquid condition. If already in solution there is no necessity to bring in pneumatolysis in order to explain their further removal upward to veins.

Wolfram and cassiterite are both found in veins at least 500 ft. above the surface of the granite, and if the result of pneumatolytic action, we are asked to believe that over 500 ft. in depth of sedimentary rock had been heated up to a temperature of about 350°C. There is no evidence of greater metamorphism of the sedimentary rocks in fissured than in unfissured areas.

The temperature at which even cassiterite was deposited in veins was probably much lower than is generally supposed.

In tin veins at Mount Bischoff, in Tasmania, chalybite (crystallized ferrous carbonate) is found. It occurs with tin and wolfram at Kanbauk, and probably elsewhere in Tavoy district, but is not easily identified. It is a mineral not the result of either pneumatolysis or of deposition at a high temperature.

We have therefore good reasons for believing that highly silicious water was the agent which leached tin and tungsten from the magma and at quite moderate temperature deposited cassiterite, wolfram, and associated minerals in veins.

THE ORIGIN OF VEINS AND HOW THEY ARE FILLED.—Vein openings are caused by forces either in or below the rocks which they traverse. The two great causes producing cracks are:

(1) Pressure generated locally in the magma forces upward, cracking and fissuring the overlying rock. Overlying rock often includes the upper part of the granite beneath which unconsolidated magma remains.

(2) Contraction, the result of cooling.

A granite magma is computed to contract fully 4% on cooling. It is obvious that portions of the magma remaining liquid when that surrounding it has consolidated will be specially liable to crack on cooling. Aplite dykes are practically veins magmatically filled with granite. Where they exist they occupy the first-formed fissures. Veins produced by upward pressure are liable to narrow gradually as they go down and to disappear at shallow depths. This is specially noticeable in veins in the sedimentary rocks. The force producing a fissure may act suddenly or gradually, may be operative for a short or long period of time, may cease at any time, or act spasmodically and repeatedly. The walls of a fissure may merely move apart when it forms, or they may be displaced vertically or horizontally or both, to a varying degree with reference to one another. Examination of the vein matter often proves movement of the walls to have taken place during or subsequent to filling.

Veins are filled by the deposit of solid matter from solutions passing upward through them. Deposition takes place from the walls inward, is determined by the cooling of the solution, and its rate is controlled by the rate of cooling. Examination of the vein matter always indicates the rate of deposition; the larger the crystals the more slowly they were deposited, and the more gradual therefore was the fall of temperature.

Veins in Tavoy district are highly silicious in all cases, and may for convenience be divided into two classes, quartz and pegmatite. There is no definite line separating the two; they gradually merge into one another. The granite consists essentially of quartz and felspar, but usually contains mica as well. A true pegmatite contains all three minerals, but the mica, which is an essential constituent, is different in type from that usually occurring in granite. All Tavoy veins contain quartz and, with very few (if any) exceptions, mica also, but this is of the type found in pegmatite, not that in granite. Felspar occurs only sporadically in quartz veins; little survives hydrothermal influences which tend to convert it into sericite or potash mica.

The ore minerals when occurring in pegmatite are usually in crystalline aggregates scattered fairly uniformly throughout it, in contradistinction from quartz veins where the ore minerals, having been deposited before the quartz, occur mostly along the walls. Veins often reopen along one of the walls, say, for example, the hanging wall, the vein filling adhering to the foot-wall, in which case the hanging-wall portion of the old vein becomes the foot-wall of the new opening. Wolfram may be deposited on both new walls, and when filled the whole vein will show a band of rich ore in the middle in places. Some wolfram-carrying veins can be seen to have been opened several times, and sometimes carry wolfram fairly evenly distributed throughout their width.

Dr. W. R. Jones in 1917 stated: "Wolfram and tin ore occur where the chilling was greatest, and this is why the hanging and foot-walls of the Tavoy lodes are, as a general rule, the richest part of a lode, and why also, as a general rule, the narrow lodes and stringers of the district carry considerably higher percentages than do the wide lodes." I regard this as somewhat misleading.

Wolfram is a mineral which, under ordinary conditions of deposition, seems to have a difficulty in finding suitable points from which to crystallize, separates out at much fewer points, and forms very much larger crystals and groups of crystals than any other of the Tavoy ore minerals. The comparison with cassiterite in the same vein is striking, and with molybdenite even more so. When wolfram or any other mineral commences to deposit in an open vein space, it must attach itself to the wall, unless it forms in space like snow, but even then it would gravitate to one of the walls. All deposition in the veins is determined by chilling, and wolfram attaches itself to the walls, not specially because of chilling, but because it is usually the first mineral to develop and there is nothing else to which it can attach itself.

My experience does not lead me to believe that the richness of wolfram veins in the same series varies inversely with their width. In the case of a vein varying in width, the narrower portions are usually richer than the wide, because the same amount of solution passes through both, the same area of wall is exposed, and the chances are that equal areas of wall will receive approximately equal amounts of wolfram quite apart from the width separating the walls. Wolfram is so fickle in its choice of a starting point for depositing that veins carrying it are notoriously patchy, and rules are generally of little utility.

Let us trace briefly the history of a vein. When a fissure opens, it is probably filled with gases in the first instance, their composition depending upon local conditions. Aqueous solutions of a highly silicious nature follow and, as soon as their temperature falls to a suitable point, wolfram, we shall say, commences to develop here and there on the walls, and continues to increase in amount until the temperature falls below the point at which it can be carried in solution. Then other minerals separate out, largely quartz, the wolfram is surrounded, and ultimately the whole vein space is filled. Veins in the sedimentaries are usually of this type. Generally speaking they show less sign of movement after the first fissuring than do veins in granite. This is what we should expect. But the vein may not fill peacefully; if wall movement takes place before filling is complete, wolfram crystals may be broken or even pulverized, the fragments being surrounded by quartz, mica, or even other ore minerals coming in at a later stage and normally at a lower temperature. Examples of this are frequent.

Secondary movement of vein walls may result in mere cracks in the minerals and these are filled by other minerals. I can show many specimens of cracks in wolfram filled by cassiterite, chalcopyrite, quartz, pyrrhotite, galena, blende, mica, and bismuthinite.

The amount of the second or any subsequent opening of the vein walls may be greater than the original one, and therefore the subsequent filling greater in volume than the original. Opening may take place along either foot or hanging wall, it may break up the vein matter itself, or even take a course in one of the walls parallel to the original fissure, joining it again and producing a horse. Pieces of the wall-rock, small or great, may break away and be surrounded by the minerals filling the vein.

PARAGENESIS OF VEIN MINERALS.—I have given this part of the subject particular attention, observations in various mines having been supplemented by the study of polished surfaces and of thin slices under the microscope.

Mr. E. Maxwell-Lefroy, in his paper on "Wolframite Mining in the Tavoy District," states that cassiterite is "frequently found partly enveloped by the tungstate, though the reverse does not occur." Dr. W. R. Jones, in his lecture delivered a year ago, says wolfram is a lower temperature mineral than cassiterite. He showed a sample in which tin ore was deposited on wolfram which he said was "of extraordinary interest as showing the exceptional in nature."

I have examined very carefully the mixed wolfram-cassiterite ores from most of the mines in the district and in the vast majority of cases there is no shadow of doubt that wolfram was deposited before tin. Dr. Jones quotes Dr. Malcolm Maclaren and East Pool, but this does not avail in Tavoy. I have seen many hundreds of samples of cassiterite filling the spaces between wolfram crystals, enclosing wolfram and carrying the impression of its striations, several where it has filled cracks in wolfram, and two excellent examples of tin-ore crystals actually formed on surfaces of wolfram. I can show many specimens from Pagave, Kanbauk, Hermyingyi, Hteinthin, Sinbo-Sinma, Kalonta, and other mines, all bearing witness that wolfram preceded cassiterite. Where is there a sample of the reverse? It seems very extraordinary that this false doctrine enunciated in 1915 should have been accepted as truth until very recently. Upon what evidence the belief was based I cannot understand for, in spite of the most persistent efforts, I have not yet either found or been shown a specimen in which tin preceded wolfram. If such exist they are certainly exceptional. I admit that the profusion in which well-formed cassiterite crystal faces occur in the mixed ore tends to make the casual observer accept tin oxide as the older. Regarding the paragenesis of wolfram, literature relating to Tavoy has in the past been entirely misleading.

As between wolfram and quartz the former appears to come in first in all cases. There is no evidence of even simultaneous growth in veins. With cassiterite and quartz it is different. While quartz generally followed cassiterite I have seen most interesting examples of simultaneous growth which at first glance look like cassiterite on quartz. Quartz crystals lining cavities have growing on their surface cassiterite crystals, but on close examination they are seen to extend below the present surface of the quartz crystal face. Upon removing one a pit is left in the quartz, which is a cast of the lower part of the cassiterite crystal. It is quite evidently a case of simultaneous growth. This phenomenon seems to me to be evidence very strongly supporting the theory of the dissolution and deposition of cassiterite by silicious aqueous solution which I have already advanced.

Pyrite, that is iron disulphide crystallizing in the regular system, is a mineral peculiar in the respect that no matter what temperature or pressure conditions obtain in a vein it may be deposited. It is found with molybdenite, wolfram, and cassiterite in the zone of high temperature deposition, with chalcopyrite, and in still cooler zones with blende and galena. It is being deposited even at the surface under ordinary physical conditions.

The succession of deposition of ore minerals in Tavoy district, commencing at the highest temperature, is as follows: Molybdenite first; in all cases in which proof is possible observation has demonstrated that it precedes wolfram. Wolfram next, followed by scheelite in some cases and by cassiterite in others, then bismuth and bismuthinite. Then come chalcopyrite and arsenopyrite, followed by pyrrhotite, galena, and blende. This order is based on the examination of polished surfaces and thin sections under the microscope.

Specimens demonstrating this are as follows: Molybdenite enclosed in wolfram, wolfram inside a quartz crystal, wolfram enclosed in cassiterite. Cassiterite enclosed in bismutite derived from bismuthinite. Fragments of radiated cassiterite crystals enclosed in mica. Quartz enclosed by scheelite. Quartz enclosed by siderite. Wolfram fragments in chalcopyrite and in pyrrhotite. Chalcopyrite in pyrrhotite. Blende in chalcopyrite and also in pyrrhotite.

It must be distinctly understood that the same vein does not usually contain all these minerals. Unless they were brought up by the magma and present in the solutions traversing the vein fissures they obviously cannot be deposited. In some cases if we sink on a zinc-lead deposit we reach the copper zone, and below that again the tin and wolfram zone, but it is the exception rather than the rule to find all these metals in the one vein. The presence of galena or blende in a vein does not necessarily imply that copper will be found below or that chalcopyrite will necessarily be followed in depth by cassiterite or wolfram. Specimens may be shown which contain wolfram, chalcopyrite, galena, and blende in the same fragment. These were not deposited at the same time. It is easily demonstrated that they followed the order mentioned. Chalcopyrite was introduced by the reopening of a vein already containing wolfram, and galena with blende on a second reopening at a later and cooler stage.

The presence of wolfram does not by any means involve the existence of cassiterite in any district. Both occur in the Tavoy district, but wolfram predominates. Both are also found in Malaya and Cornwall, but there tin predominates.

Based upon the opinion that cassiterite is a higher temperature mineral than wolfram, Dr. Jones put forward a theory that wolfram will give place at depth to cassiterite in Tavoy district. In a matter of such vital importance to the mining industry of Lower Burma, theories should be based on facts, and facts can only be arrived at by careful and comprehensive examination of the mineral occurrences of the district. This theory I cannot believe to be based on facts, for I know enough of the district now to state that facts point in exactly the opposite direction. I am well acquainted with a number of mines in which cassiterite and wolfram occur together, and if time permitted I should like to give full particulars with reference to several such areas. Time does not allow me to do more than summarize. In general in such tin-wolfram areas on the contact the ratio of cassiterite to wolfram is greater in veins in the sedimentary rocks than in those in the granite below. When in granite the ratio of tin to wolfram appears to fall as we move down from the vicinity of the contact. Let those of a speculative bent sink on a cassiterite vein hoping that it will, like Sadisdorf tin-mine, give place to wolfram, and they may not be without hope; but woe to the man who sinks on a wolfram vein in Tavoy hoping to get tin.

WOLFRAM.—Mr. E. Maxwell-Lefroy in writing concerning this mineral says "crystals are seldom seen." Perfect crystals of either wolfram or any other mineral are practically unknown, since such must display perfection in both symmetry of form and smoothness of surface. All wolfram is crystalline, that is, it possesses both definite external form and definite molecular structure. Take a pellet of waterworn wolfram, break it with a blow, and some of the fragments will show brilliant surfaces; these are cleavage planes present in crystalline but never in non-crystalline substances.

Simple single crystals of wolfram are rare, as the formation of such demands very slow deposition under quite uniform conditions. Rapid deposition results in an acicular form in which the individuals are scattered at indefinite angles throughout the mass of the quartz. Wolfram has never been observed to develop in microscopic crystals which pervade the matrix, but always occurs in relatively speaking coarse masses. Bladed, prismatic, and tabular forms are common; all are striated externally, the prism across and other forms parallel to the length of the crystal. Rich patches in veins, especially in the sedimentaries, present fine examples of divergent crystals. Straight lamellar structure is common, and curved, due to oscillatory twinning, has been observed. Complex forms of twinning are to be seen resulting in structure like the polysynthetic twinning characteristic of microcline, but with the lamellae often curved and lying at an angle of about 40° to one another. This form of wolfram breaks only with much greater difficulty than the more ordinary forms and also resists decomposition much more strongly. When exposed to weathering, pebbles of it develop this diagonal sieve-like structure on their surface. Etching produces the same result, and a flat surface cut at the proper angle and polished, but not too highly, displays the same structure by reflected light. In thin section wolfram is usually opaque, but sometimes is translucent, in which case it is blood-red by transmitted light and weakly pleochroic.

CASSITERITE.—The principal characteristic of cassiterite of Tavoy district is the unusual commonness of the lighter shades, "black tin" being quite exceptional. It occurs in shades from nearly water-clear to amber, brown, and deep chocolate; also in a variety of tones of grey as well as red and reddish-brown. Even fairly good crystals are uncommon, and either in symmetry of form or size none in Tavoy can compare with those found in Nigeria.

Cassiterite is always crystalline in structure, there being three quite distinct varieties:

(1) The ordinary form in which crystals are hard and apparently homogeneous. Some specimens of this are very strongly pleochroic, which is unusual.

(2) Aggregate. This form is comparatively common. It grows inward from nuclei on the walls of veins showing concentric structure with frequently alternating bands of colour. The outward form is pseudo-crystalline, and under the microscope it shows irregular aggregate polarization. Subjected to a blow such pseudo-crystals break up to powder. They are so brittle that they cannot be properly polished.

(3) Prismatic. This form is more uncommon and does not resemble ordinary cassiterite. I have obtained specimens from four different mines, among which are Hermyingyi and Kalontā. It is found in small prismatic crystals radiating from a central nucleus. They show aggregate polarization between crossed nicols. The existence at Tavoy of this form of cassiterite has not, as far as I am aware, been previously recorded. It has two modes of occurrence: (1) in bands parallel and alternating with quartz—crustification—in veins, and (2) with the interspaces of prisms and groups filled with soft micaceous mineral. The first specimen of this I saw was picked up on an old alluvial dump, and though it weighed about a pound had been rejected as worthless by Chinamen. It is so fragile that streak or hardness tests are difficult.

The second form of tin mentioned resembles wood-tin somewhat in so far as it consists of concentric layers and acts very similarly under the microscope, but differs greatly in brittleness, wood-tin being anything but fragile.

Cassiterite is the most difficult of all minerals to identify, as it exists in so many forms and colours.

SCHEELITE.—This mineral occurs more commonly than is generally supposed, but it is not recognized, first, because it bears a certain resemblance to quartz, and, second, because it so readily alters superficially to tungstite that without either chemical tests or the microscope it is readily mistaken for tungstite. Scheelite sometimes develops in veins simultaneously with quartz, the two together filling spaces between wolfram crystals. In other cases it separates later than quartz, surrounding well-developed crystals of that mineral. Secondary scheelite is not at all uncommon, being the result of the action of certain solutions on wolfram. Scheelite is a crystalline mineral but even when primary it is only rarely that well-developed crystal faces are to be seen. When secondary it sometimes takes the crystalline structure of the wolfram from which it is derived, and at other times it is crypto-crystalline. When pure it is white, but impurities may give it various shades of yellow, brown, or grey. There is no simple field test for its recognition. If a mineral associated with wolfram is easily scatched by a knife, has great density, and a lustre inclining to pearly on a fractured surface, scheelite should be suspected, and a sample sent to some one competent to identify it.

MOLYBDENITE.—Molybdenite was probably the first of Tavoy ore minerals to have been deposited in veins, for it is definitely established that it preceded wolfram in all cases in which evidence of paragenesis is obtainable. In Tavoy, though occurring in many veins, it is found in such small quantities and so erratically distributed that it is of little economic importance. The veins carrying it may be in either granite or sedimentaries, but more commonly in the former. It occurs associated intimately with wolfram and cassiterite, but appears to be characteristic of the zone at or below the bottom of the wolfram. In the latter case it is frequently mixed with mica as a layer lining the vein walls.

Molybdenite may be identified with certainty in the field by, first, its making a plumbago-like mark on paper, and, second, by its scales being flexible and non-elastic, that they bend without breaking and remain bent. No other mineral responds to both these tests. Like other sulphides, molybdenite is readily decomposed by oxygenated water, the sulphur going off in solution and the oxide—molybdite—remaining. This in its turn is dissolved by water containing alkaline carbonates. Molybdite is somewhat variable in appearence, and may be readily mistaken for tungstite or meymacite as both may be yellow, either pure sulphur-colour or greenish. Both varieties are crystalline, the former microscopic and the latter in very beautiful silky fibres.

BISMUTH.—The metal is quite characteristic in appearance and cannot easily be mistaken for any other mineral. It readily takes up oxygen, forming a black sub-oxide, which in turn absorbs oxygen and carbonic acid, turning grey and ultimately pale yellow, and yielding the basic carbonate, bismuthite. Native bismuth is known to occur in only two or three parts of the district.

The sulphide of bismuth, bismuthinite, is somewhat more widely distributed though not by any means common. It occurs in the same veins with wolfram, cassiterite, and molybdenite, often in contact with the two former, also associated with them as a primary mineral in granite. It is always fibrous in structure, steel grey in colour with high metallic lustre. Sometimes it is hair-like in separate fibres. It is often found in microscopic crystals throughout quartz to which it gives a smoky grey to black appearance. When exposed to the air it loses its lustre, turning black, then grey to green, and finally pale yellow. In the grey to yellow condition it is found in sluicing concentrate and is called bismuth ochre. It is really the basic carbonate (bismuthite), the oxide (bismite) not being known in Tavoy district as far as I have seen. The grey varieties contain some undecomposed sulphide.

Bismuthite derived from the sulphide is readily distinguished from that yielded by the metal, as the former always shows the fibrous structure of the sulphide, whereas the latter is without definite structure.

The simplest test for bismuth is to place a fragment in a little cold hydrochloric acid not sufficient to completely dissolve it, wait a few minutes till action has ceased, pour the acid into a glass of water, when it will turn milky and a heavy white precipitate will fall.

OTHER ORE MINERALS.—Other ore minerals found in Tavoy district include chalcopyrite (which yields covellite and chalcanthite), arsenopyrite, pyrite, pyrrhotite, galena, and blende, the last yielding goslarite. None of these are of any economic importance in Tavoy. Siderite or chalybite is found at Kanbauk, but is of only scientific interest. Pyrite is ubiquitous. Chalcopyrite is not uncommon in wolfram-bearing veins and came in at a later stage. Pyrrhotite has been observed in only a few areas, and is always associated with galena and blende, usually in small quantities. Its introduction was later than chalcopyrite. Pyrrhotite alters to pyrite, a somewhat peculiar change. The structure of the resulting pyrite is highly characteristic. Such pyrite is found only between the bottom of the oxidized ore and the surface of the unoxidized sulphide, and its porosity renders it very susceptible to further oxidation, which sometimes takes place very rapidly even in ordinarily dry air. Arsenopyrite is found in only small quantity in a few veins, and is not usually intimately associated with wolfram. Magnetite is found in veins in large quantities in some localities as well as other iron ores, but they are not likely to be of any commercial value for some considerable time.

DECOMPOSITION OF WOLFRAM. — The rapidity of the decomposition of any solid substance caused by contact with fluids depends to a great extent upon the ratio of exposed surface to mass. Wolfram in most of its forms breaks up readily along its cleavage planes into thin laminæ, and therefore under given conditions decomposes more rapidly than other less fragile forms. Wolfram is a ferrous-manganous tungstate, the iron and manganese in it existing in a condition prone to take up more oxygen, thereby causing the breaking up of the mineral. Since ferrous and manganous compounds act so similarly, it will save much repetition if we regard wolfram as a ferrous tungstate. We shall therefore take iron throughout this argument to include manganese.

Wolfram is the result of combination of the basic radicle ferrous oxide with the acid radicle tungstic oxide, which combination has a definite and uniform intensity. If wolfram comes in contact with any substance in solution which exerts a more intense attraction than does tungstic oxide for the basic radicle, the mineral will be broken up, a new compound of iron formed, and tungstic oxide set free. Similarly with the acid radicle.

There is no mineral containing the basic radicle, ferrous oxide, in any quantity which can withstand for a prolonged period the action of atmospheric oxygen and water; all sooner or latter break up, the iron being oxidized to ferric hydrate, which is practically iron-rust, a very stable substance. The two minerals containing ferrous iron in which it is most firmly attached are ilmenite, the titanate, and wolfram, the tungstate. When certain acids come in contact with wolfram, they break up the union of its radicles, taking away iron and leaving tungstic oxide; this I call the "acid decomposition" Strong alkalies similarly bring about a separation of the wolfram radicles, combining with the tungstic oxide; this I call the "alkaline decomposition" of wolfram.

The bulk of ground-water in the topics does not contain free oxygen on account of the large quantity of matter of vegetable origin which it carries in solution, but rain water, which often passes down veins, does contain much free oxygen. Ground-water always carries alkaline carbonates as well as free carbonic acid in solution. Oxygenated rain-water passing down veins comes in contact with pyrite and converts the sulphur into sulphuric acid. All these substances, namely, alkaline carbonates, carbonated oxygenated water, and sulphuric acid dissolve one or other of the wolfram radicles, breaking it up. These processes of dissolution in nature are extremely slow, but the agents I mention, though useless for dissolving wolfram in the laboratory, when given the necessary time, do their work just as completely as the most powerful reagents the chemist can apply.

The acid decomposition of wolfram is that which most commonly takes place in veins because sulphides are usually present. They yield sulphuric acid on oxidation. This combines with the iron, yielding ferrous sulphate (green vitriol), which is freely soluble in water, passes away in solution, comes in contact with oxygen when it approaches the surface (as it must do ultimately), breaks up and deposits the hydrated metallic oxides either as a shining black incrustation on adjacent solids or as a black porous burnt-looking mass. The residue left where wolfram was is tungstic oxide, the mineral tungstite, commonly called tungstic ochre. Its colour is yellow, varying from pale to nearly orange and sometimes with a greenish hue. Its structure is usually porous, as it is incapable of occupying the whole space of the original wolfram. The reticulation it usually displays in section under the microscope or even on polished surfaces shows very plainly how decomposition started from cracks and cleavage planes, gradually extending inward. Examples of the process in progress are common, but large masses of tungstite are rare on account of the facility with which it is dissolved by alkaline solutions, when it passes away as soluble alkaline tungstate and is usually lost. If such a solution, however, encounters acid water, it is at once decomposed and hydrated tungstic oxide or tungstic acid, the mineral known as meymacite, is formed. This is to be found quite commonly in cavities in veins and exists in two forms: (1) as sulphur, yellow, moss-like tufts or radiating crystals, and (2) as small but often well-developed amber-coloured crystals, commonly single, sometimes in groups. These two varieties are both readily soluble in alkalies, but it is not certain whether or not they are of identical composition. Both are hydrated.

The acid decomposition of wolfram takes place most readily in cases where wolfram and pyrite have developed in very close association: this is the type of ore which yields the largest masses of tungstite.

The alkaline decomposition of wolfram also takes place in veins, but it is of most importance as the process which robs alluvial deposits of the tungstates contained in them.

Several detrital deposits in Tavoy district contain rounded pebbles of wolfram. These usually display a rough etched surface, a sure sign of superficial decomposition. Since these deposits answer to every criterion by which we can classify detrital deposits as alluvial, we must regard them as true alluvials of very recent origin. Ordinary alluvials contain no wolfram, but we must not argue that they never contained it, for it is practically certain that they did when they were formed and that it has been removed since.

Laterite, though frequently stanniferous, never carries wolfram, for the solutions causing laterization dissolve tungstates, but quartz pebbles enclosing wolfram and protecting it from solvents have been found occasionally in both laterite and old alluvials.

The alkaline decomposition of wolfram is brought about by alkaline carbonates which are present in all ground-water. These dissolve out tungstic oxide from wolfram. If out of contact with oxygen, the excess of carbonic acid combines with iron, manganese, and (in case of scheelite) calcium, forming soluble bicarbonates, and thus, both wolfram radicles going away in solution, the mineral entirely disappears. This happens in alluvials deep below water-level.

When in either veins or detrital deposits wolfram is exposed to the simultaneous action of alkaline water and oxygen, the tungstic oxide only is removed, the iron and manganese take up oxygen, assume their more stable form, and remain behind as a black porous cindery mass. Such ferruginous residues often contain small particles of undecomposed wolfram, also some scheelite, but never tungstite. Hydrochloric acid dissolves from this cindery mass the metallic hydrates very readily, but leaves behind wolfram or scheelite.

Burnt wolfram of the native miners, common in many mines, is the ferruginous cindery residue I have described.

Scheelite breaks up more readily than wolfram with all natural solvents. With sulphuric acid, sulphate of lime is formed and goes off in solution as a rule, but in some instances it has been observed in pearly scales of gypsum in intimate association with the residual tungstite.

Another mode of decomposition of wolfram results in its transformation into scheelite. This change is demonstrable only in sections under the microscope. It is of a more complex nature, and need not be discussed further at present.

In this connection it should be noted that in wolfram veins in which pyrites abounds, the ferruginous residue from its oxidation often covers wolfram in such a way as to mask its true nature. In more than one case I have seen such valuable mineral discarded. All ferruginous and black cindery material should be crushed and panned now and then so as to ascertain its true value.

CONCLUSION.—I wish to record my high appreciation of the advice and valuable assistance which Mr. J. Coggin Brown has so freely placed at my disposal whereby my work has been very materially facilitated. I desire also to thank various friends for the kindly interest which prompted them to give me samples of scientific value.

In conclusion I must say that we should not accept as divinely inspired the geological lore taught us in our school or college days. We are supine if not sceptical when such theories are not in accord with natural phenomena. They were the result of observation by people in the past in no way superior to ourselves but in scientific equipment decidedly inferior. Honesty of purpose is as important as patient observation and clear thinking in those seeking the truth.

The theories I have enunciated are not put forward in any dogmatic or self-assertive spirit, but in the hope that the discussion of them will make us all wiser, and if they stimulate in a few people a keener interest in the origin of the ore deposits of the Tavoy district I shall not have worked in vain.

When Mr. Morrow Campbell's paper was delivered as a lecture at Tavoy, it caused much interest and elicited discussion. We give in the following paragraphs the comments made by Mr. J. Coggin Brown, Chief Inspector of Mines in Burma, and a member of the Geological Survey of India.

Mr. Coggin Brown said that the lecture could be divided into two parts, the first consisting of a large amount of fact, and the second of a certain amount of legitimate theory. He was aware, perhaps to a greater extent than anyone else present, of the vast amount of manual work which the preparation of the mineral specimens had entailed. He complimented Mr. Morrow Campbell on the beautiful results he had obtained. In addition, his account of the lodes of Tavoy district was the fullest which had been given, and contained several new features of great interest. His detailed description of the various ore minerals would prove invaluable to future workers. His note on the decomposition of wolfram was a fine piece of chemical research, carried out under great difficulties.

Mr. Morrow Campbell had placed a number of matters which were previously speculative into the region of incontrovertible truth. Soon after he, Mr. Brown, came to Tavoy, nearly three years ago, he began to have his doubts about some of the statements of previous writers. In 1916 he had written that wolfram appeared to have been usually the first mineral to appear in mixed lodes, but that in certain cases the converse seemed to be the rule. He now freely admitted that there was no evidence at present to support the converse and he thanked Mr. Morrow Campbell for clearing up the matter. He associated himself entirely with Mr. Morrow Campbell's views on paragenesis.

Another discovery which was due to Mr. Morrow Campbell's work was the recognition of the occurrence of wolfram as a primary constituent in the local granites. We knew previously that cassiterite occurred in the granites and we were searching for wolfram in the same situations. Mr. Morrow Campbell found it, and all the credit for this important find was his. It was a matter which might have far-reaching economic effects.

Regarding the purely speculative portions of the discourse, he (Mr. Coggin Brown) spoke of the difficulties of the subject. Certain classes of ore deposits were easily explained, because they were formed under conditions which were not very abnormal, and which could be reproduced in the laboratory. But when it came to tin and wolfram lodes—the miscalled "high temperature deposits"—we were dealing with conditions which never had been, and, in the speaker's opinion, never would be reproduced artificially. He thought Mr. Morrow Campbell was rather hard on the pneumatolytic theory, which had held the field for a long time, and which had been used by most investigators to explain the origin of cassiterite deposits in many parts of the world. Dr. Jones was quite right when he said that it had been adopted by the American writers on this class of ore deposits, though this was no reason why it should not be superseded by a better one. The speaker doubted whether it had been used to explain the origin of wolfram lodes to the extent that Mr. Morrow Campbell seemed to indicate. However, he too had to give up the pneumatolytic theory to a great extent, because he found that it could not account for most of the lodes of the Tavoy district.

In a paper read before the Indian Science

Congress in 1916 he had adversely criticized Dr. Bleeck's theory concerning the wolfram and tin lodes of Tavoy, especially as to the presence of a distinct "mineral zone," a wolframite-cassiterite-columbite zone, and the presence of tourmaline introduced by pneumatolytic processes from the intrusive granite. He also brought forward arguments illustrating his own pegmatitic theory of the formation of the lodes as contrasted with that of Bleeck. In the case of the wolfram and cassiterite-quartz veins of which the pegmatitic origin was not so clear, it seemed to him reasonable to regard them as a hydro-thermal phase of pegmatites. In addition he would like to state that he then admitted the probable existence of pneumatolytic actions on theoretical grounds to a certain extent, and ascribed the formation of greisens to the same cause, though denying that boron and fluorine compounds could have had great part in the changes. He also suggested that the place of boron and fluorine might have been taken by sulphur and arsenic. His own views were that the characteristic lodes of Tavoy were of pegmatitic and associated hydro-thermal origin usually. The pegmatitic genesis of some of them was indisputable, and they had it on high authority that a hydro-thermal phase of most pegmatites was now recognized, represented by deposits of silica with or without ore minerals in fissures as a continuation of the pegmatites. He asked if it was not reasonable to suppose that many of the local quartz lodes were a phase of ultra-pegmatitic development, especially as there was field evidence of one passing into the other sometimes. Arguing on these lines he regarded some lodes in Tavoy as quartz, mica, sulphide, wolfram, and cassiterite pegmatites. Some of the well-known lodes in Mergui and Thaton were quartz, mica, tourmaline pegmatites with wolfram and tinstone. The Byingyi lodes in Yamethin district were, according to his colleague, Mr. Heron, quartz, mica, beryl pegmatites carrying wolfram. Other examples occurred in India.

It would be seen that he agreed with Mr. Morrow Campbell as to the important part played by water in the formation of the lodes, but he was sorry that Mr. Morrow Campbell had invoked the aid of meteoric water. He was afraid he could have nothing to do with that. All the peculiarities which the lecturer had explained on this hypothesis could be accounted for by his own one. He instanced the extraordinary length of some of the thin lodes of Tavoy, the regular irregularities of many of the larger lodes, the structure of both, and most of all, the evidences of deposition at comparatively low temperatures. These were all compatible with the theory of pegmatitic and hydrothermal origin. He would like to know how the lecturer accounted for the formation by meteoric water of the mica walls which almost always bounded lodes in sedimentary rocks and, also, of the greisen bands found in similar positions where the lodes cut through granite.

Mr. Morrow Campbell found it difficult to account for the enormous quantities of water issuing from the earth's surface in certain regions of the world, if such water was of magmatic origin. He (Mr. Coggin Brown) cited the work of Gautier, quoted by F. W. Clarke in "The Data of Geochemistry," as containing facts that go some way toward an explanation. One cubic kilometre of granite can yield from 25 to 30 millions of metric tons of water. At high temperatures this would be converted into an enormous volume of vapour, without taking into consideration the vast quantities of other gases which would be emitted.

There was another matter to which he would like to refer, and that was the economic importance of the occurrence of wolfram and cassiterite in decomposed granite, pegmatite, and aplite. The lecturer had not emphasized this as much as the speaker would have liked, and he regretted to say that many mine-owners in Tavoy did not appear to have realized it at all. Large quantities of the ores they were seeking undoubtedly occur in profitable quantities in such locations, and he hoped that more attention would be paid to their exploitation in the future than had been done up to the present time.

Concluding, Mr. Coggin Brown expressed his thanks to the lecturer not only for the pleasure of hearing his views, but also for the instruction that was to be derived from them.

The Cockerill iron and steel works at Seraing, near Liége, were dismantled and destroyed by the Germans. A thousand machine tools, and cranes, electric motors, etc., and all the raw material were sent to Germany. Only two of the seven blast-furnaces were left standing, and nine of the eleven rolling mills were dynamited. M. Leon Greiner was imprisoned in Celle castle along with the redoubtable M. Max. It is estimated that £2,000,000 will be the cost of rehabilitating the works and that it will take three years to do so.

MOTOR TRANSPORT UNDER DIFFICULTIES

By J. A. L. GALLARD.

Lorries are likely to be more extensively used for out of the way mines, and the experience gained with mechanical transport on the Western Front under the severe conditions that have ruled there should be valuable. The writer, now released from the Army, spent three years in the war area; after being on ambulance work, he was commissioned and given charge of an Ammunition Column.

As far as mechanical transport is concerned the Great War has undoubtedly proved to be the most exacting reliability trial ever known. Those who have been engaged upon transport work on the Western Front have marvelled at times that mobile machines constructed of metal and wood have been able day after day to move under their own power over the road surfaces torn by shell fire, through mud swamps, over roughly laid plank tracks and corduroy roads. When one remembers that many comparatively slender parts enter into the construction of a motor car and a motor lorry (or "truck," as the Americans term a lorry), it is indeed surprising that the mechanical troubles experienced were not even more numerous than was actually the case. There were difficulties enough; but experience teaches, and those who did not neglect to learn were in a position to forestall some fresh troubles.

Most probably the experience gained during the war in connection with the usage of mechanically-propelled vehicles, and especially those driven by internal-combustion engines, will lead to similar machines being employed in increased numbers in the development of industries and of trade at home and abroad. Of chief interest from the point of view of the readers of the Magazine is the question of the use of motors for mine transport, in the carrying of supplies from, and the mine produce to, the nearest railhead. On some mining fields motor lorries and tractors are being run already, but I have never seen published any information regarding their working. Perhaps some overseas reader of the Magazine will oblige with his experience in this connection. Data relating to breakages, replacements, and costs would be particularly interesting. Meanwhile some notes are given herewith based upon an experience of close upon three years in Belgium and France with light cars and lorries of various makes.

Light vans, with dual tyred (pneumatic) rear wheels, capable of carrying 15 cwt., or with single solid rear tyres and strengthened chassis, capable of carrying 20 cwt., might be found serviceable in some mining camps. But the more general demand is likely to be for vehicles of a carrying capacity of 30 cwt. to 3 tons. The latter is the capacity of the lorries used on the Western Front for ammunition service, though some of the same vehicles when working at home have carried up to five tons.

THE SLEEVE-VALVE ENGINE. — One of the surprises—at any rate to the writer, whose pre-war motor experience was confined to touring cars—was the way the sleeve-valve engine when fitted to heavy vehicles stood up to the hard work it was called upon to do in the war area. The war has proved that with a good regular driver a sleeve-valve engine may be run for years without any serious trouble developing; although, of course, it is not desirable to keep any internal-combustion engine going for a long time without thorough decarbonizing and attention to the wearing parts. I know of a 30 cwt. sleeve-valve-engined lorry which was run daily for a couple of years (excepting on a few occasions, when springs or tyres had to be changed) and so far as I can remember the cylinders were never taken off during that period, though the heads were probably removed, and these, with the tops of the pistons, scraped.

A minor difficulty associated with the sleeve-valve engine is the complete withdrawal of the water from the pockets of the cylinder-heads in frosty weather. The use of a syringe pump is necessary, whereas the water jackets of most motor engines are drained simply by opening a tap at, or removing a plug from, the base of the radiator.

SPECIFICATION SUGGESTIONS. — Just as every type of lorry has a favourable feature of its own, so each make probably has some peculiar defect. Only a fairly lengthy experience with a number of vehicles of the same type, followed by a similar time spent with those of another maker, and so on through the whole list of lorry manufacturers, could fairly settle the often-asked question: Which is the best lorry on the market? What the writer would be inclined to select for transport work under severe conditions as regards roads, or apologies for roads, would be a highpowered but low-geared vehicle (chain or shaft driven), with rear wheels which can be quickly fitted with a series of skid chains, hooks being already fixed to the rims; tow-hooks at front and rear, with substantial brackets and bolts (not rivets); long springs of highest grade spring steel, with holding-down bolts and shackle pins of good dimensions; easily get-at-able magneto and carburetter; sturdy steering (with all nuts split-pinned); and of course a ground clearance higher than that usual for British roads. The level of the lubricant in the engine, gear box, and differential should be quickly ascertainable, and each of these units should be easily flushed out.

Special mention has been made above of fitting a number of skid chains to each rear (driving) wheel. The reason is that when only one is fitted — and some rear wheels are made so that they will take only one — the wheel is very liable to spin round until the chain comes in contact with the ground and the sudden jerk thus caused severely strains the transmission, sometimes resulting in a broken driving shaft. In the case of a chain-driven lorry the suspension should be such that the rear sprockets do not come very near the ground under normal conditions; otherwise in bad ground stones may easily get between the sprockets and the chains with serious results.

TRACTORS FOR SOFT GROUND. — For transport where there is only soft ground with no hard bottom and into which ordinary lorries would sink to their axles there is the caterpillar tractor, which has been so extensively used in the war area for hauling big guns. This has a revolving band or track, and can move over almost anything. The caterpillar is a slow-moving vehicle, but it is almost sure (failing mechanical break-down) and can haul a large tonnage carried on broad-wheeled trailers. The 75 h.p. caterpillar itself weighs about five tons, and on gun haulage in the war area has pulled up to about twenty tons.

More mobile than ordinary lorries, though not so sure of getting out of bad places as a caterpillar, since they have wheels, are the lorries of the four-wheel drive type. In their case the power can be applied to both sets of wheels, or to either set. These have also been used regularly for gun haulage over bad ground on the Western Front, although fitted with ordinary lorry bodies.

LETTER TO THE EDITOR

Slime Concentration.

The Editor:

Sir—The patent specification of Mr. Walter McDermott's, which you publish in your October issue and refer to in an editorial, seems to me to show that an important influence in slime treatment has practically escaped recognition hitherto. Such statements as the following occur in the specification:— "This loss is largely due to the very finely pulverized portion of the mineral which flows off in suspension in the water from failure to settle....A large quantity of water is employed and the very fine particles of mineral in suspension in this water can only be separated by provision of ample time and large settlement area....A large surface for settlement and a slow rate of flow of the water."...Mr. McDermott is here describing existing practice, and seems to express the current belief that nothing but gravity operates in settling fine slime and that it does so in accordance with Stokes' Law. Then he proceeds to describe how, by the provision of a smaller inclination and a slower flow, he expects to obtain a more efficient deposition of the mineral particles, while at the same time the "lighter" particles are kept in suspension by the shaking motion imparted to the apparatus. What exactly are lighter particles? The net result of the arrangement, if it acts as described, would seem to be to facilitate the settlement of those particles which settle readily anyhow and make more difficult the settlement of those less easy to settle, in fact to increase the very troubles he mentions in his opening statement.

An extract from a recent paper by Professor Truscott, issued under the auspices of the Tin and Tungsten Research Committee, is not without interest as illustrating the same current belief, while the extract does actually contain a relation of observations sufficient to account for half the phenomena of slime concentration, though their value seems to have passed unrecognized by the author. Writing of the retention on sloping surfaces of elutriated slimed cassiterite which failed to settle against a rising current of 0·06 mm. per sec. (equivalent to a diameter of the cassiterite particles of 0·005 mm.): "What was remarkable with them all was the quick deposition of material so fine as to have overflowed the pan. There was in this fact almost the suggestion that the opportunity for *attachment* was the one advantage which a collecting surface possessed, and that there was some force other then friction which retained the particles so *attached*. It was, moreover, observed that the particles, though minutely small, in no sense became merged in a mass, but retained their *individual freedom* to the extent that as the water drained out from between them they assembled themselves in lattice-shaped patches forming a regular criss-cross pattern" (italics mine). The concluding observation simply records the tendency of sand undergoing transport by flowing water to form banks and channels as load conditions change, though one critic of Professor Truscott's paper saw in it a chance to recommend a suitable "chemico-physical" experimental programme to account for it, and went on to state that the difficulty of separating fine slime is well known to arise from the increase of the ratio of surface to weight as the size of the particles diminishes, still sticking at Stokes. Professor Truscott seems to believe that the fine particles settled become attached to the surface, although he observed that they retained their freedom of movement.

Far more important than gravity in settling slime on a frame is the change in rate of velocity of flow downward through the film of water. Particles in a fast-moving stratum tend to pass into a slower-moving one and so reach the bottom where the current is slowest at a rate they never would do if gravity alone operated. Once there, the same cause operating tends to keep them there, subject to the fact that the velocity of flowing water cannot be represented by a number of parallel sheets moving with decreasing velocity in depth, but that small vortices and eddies exist especially at the bottom. So settled, the particles do not stick to the frame; they move down it, slowly, some of them, but still they move, and the vortices give them a sort of hopping motion.

This differential velocity exists on the rag frame; concentration of slime would be a practical impossibility if it did not. There seems no particular necessity to hitch the simple and efficient Cornish frame on to a carding machine, or to shake a frame weighing more pounds than the material on it does ounces to secure (even if it did) what is already attainable by simpler means. Many slime thickeners and settlers owe their efficiency to the perhaps unconscious incorporation of this principle. It acts in a tank where baffle plates are suspended a little way below the surface, and it would act if a punched screen were hung horizontally just below the surface.

Beringer has shown that slimed cassiterite suspended in water in a phial attached to the shaking frame of a vanner will not settle, this arrangement eliminating flow conditions.

R. T. HANCOCK.

Jos, Northern Nigeria,
November 28, 1918.

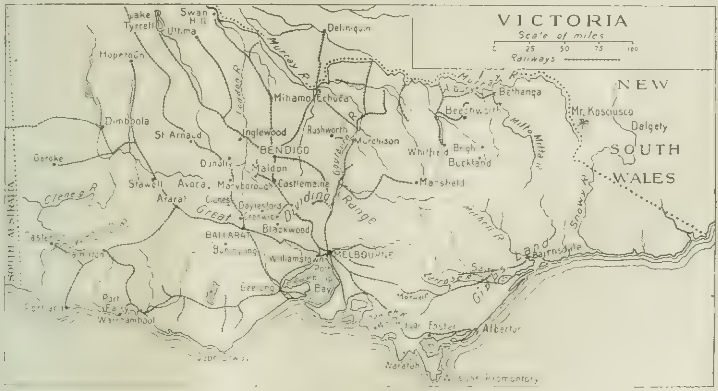
NEWS LETTERS.

MELBOURNE.

October 5.

WOLFRAM IN NORTHERN TERRITORY.—Government mining officials have recently paid a visit to the wolfram district in the Northern Territory. The industry is not very active, but a number of mines are being worked. Many men are now working at Hatch's Creek; 16 tons of wolfram was sent away by camel team in May and 12½ tons in June. Wolfram has been found on the King River, about 20 miles north-east of Marranboy. The locality is in, or bordering upon, some of the most rugged and precipitous country in the Territory. Mr. Dan Dillon has returned from the new field, bringing with him about 1 cwt. of wolfram, which he picked up along the ridge. He immediately returned to the field with a number of men from the Marranboy tinfield. The wolfram is in leaders, in granite country; no lodes have yet been found. The Wolfram Camp mine looks well for a good future. It is said to be the best wolfram mine in Australia. Though it has only been worked with a few men, £100,000 worth of wolfram has been taken out. The shaft is on a high hill opposite the crushing and dressing plant. A large quantity of the ore is bagged at the mine. The lower grade, and that containing copper, is taken to the mill and dressed up to high-grade wolfram. The copper removed in dressing is shipped to southern smelters. Some hundreds of tons of copper ore have been shipped. In order to test the lode at greater depth a tunnel was driven into the hill to cut the lode, and after driving 400 ft. the lode was reached, showing a width of 17 ft., worth 7% wolfram, and also valuable copper contents. This tunnel will facilitate the working of the mine and give over 100 ft. of backs.

MORWELL BROWN COAL.—The immense deposits of brown coal at Morwell, Victoria, have been mentioned in the Magazine several times. Many proposals have been made to gasify this coal and generate electric power thereby. The Victorian Treasurer, Mr. McPherson, announced in his budget speech last week that the vote of £100,974 for the Mines Department included £51,000 for development work in connection with these deposits. He remarked that the outstanding necessity in the development of the State's mineral resources is the utilization of brown coal to meet the rapidly growing demand for electrical energy arising from the new industrial activity in the Melbourne area. Initial steps are being taken to establish a 50,000 kilowatt power house at Morwell. This plant will be merely the forerunner of a much larger plant that will be called into being by the continued growth of present industries, and the establishment of new ones, dependent primarily for their existence on large supplies of cheap energy. A board of control is to be appointed to ensure that all State and statutory electrical supply undertakings throughout the State shall adopt standards such as will permit of the inter-connection of the various power plants, and render any of them capable of serving the widest possible field in times of industrial stress or national emergency. In connection with brown coal development, it is hoped that a briquetting industry will be established, either for the supply of raw coal briquettes, which are so successfully utilized in central Europe, or as retort-residue briquettes, which are beginning to find favour in the United States.



CADIA IRON DEPOSITS.—The township of Cadia, in Bathurst district, New South Wales, was hard hit by the closing down of the Cadia copper mine, and was nearly deserted. It is taking on a fresh lease of life, and vacant allotments that one could scarcely give away a while ago now possess a value, and a rising one. The revival is due to the activities of Hoskins, Ltd., of Lithgow, who have acquired the deposit of hematite ore near the copper mine. A railway, running from Spring Hill, on the main western line, is nearing completion. The ore will be conveyed by aerial ropeway from the mine, across the valley, nearly a mile, to the bins, from which it will be run direct into the railway trucks, so the cost of handling will be on the low side. The power house is nearly completed, and the works will be lit by electricity. As the ore is said to produce a steel equal to the best British and American, the possibilities of future expansion are great. It is estimated that a million tons of high-grade ore is in sight. There are rumours that the copper mine is to resume operations shortly.

WEST AUSTRALIAN STEEL.—It is intended to establish electric steel works in West Australia, the company having the matter in hand being the Australian Electric Steels Co. Ltd. This company is incorporated at Adelaide, and has already established works at Sydney, at which 120 men are employed. The Government power station, in Perth, will supply the current at an exceptionally low cost, and scrap necessary to keep the works going for a considerable time is obtainable at short notice. The plant, however, which is of a very special character, has yet to come from England, and no definite date can be given for its arrival in Australia. A site of some seven acres has been secured at East Guildford in close proximity to Cumming & Smith's superphosphate works. The plant that it is proposed to erect will be twice the size of that in use at the Sydney branch of the company's operations. It will include an electric steel-refining furnace, the product of which is high-grade steel in different forms, such as tools, axles, and tyres, machinery parts, and mining and battery steels of different varieties. It is also designed for the manufacture of special chrome steels for crushing plants, and manganese steel for the wearing parts of rock-breakers, ball-mills, etc. The works will also have attached to them a fully-equipped laboratory and testing plant. An industry of this kind is one of the special needs of Western Australia. So many enterprises are at a standstill at present for want of suitable machinery, or machinery parts, and there are scores of mines on the Eastern and Murchison goldfields which are starving for the wherewithal to carry on their operations.

TORONTO.

January 6.

MINERAL PRODUCTION DURING 1918.—The Canadian Department of Mines estimates the total value of the mineral production for 1918 at not less than $220,000,000, as compared with $189,646,821 for 1917. The output of the more important metals is estimated as follows: Gold $14,750,000 in value; silver 20,800,000 oz.; copper 117,000,000 lb.; nickel 91,500,000 lb.; zinc 36,000,000 lb.; pig iron 1,182,000 tons, and steel ingots and castings 1,010,000 tons. The production of coal is estimated at about 15,180,000 tons, as compared with 14,046,759 tons during 1917.

PORCUPINE.—Labour conditions show continued improvement since the closing of the munition factories, as large numbers of the men released are seeking employment in the mining districts. The operating mines are steadily increasing their working forces. At the Dome Mines active preparations are being made for the resumption of milling. Underground work has been steadily maintained and there is about 400,000 tons of ore ready for the mill. Owing to favourable developments below the 700 ft. level down to a depth of 1,250 ft., the average grade of the ore reserves is stated to have been considerably increased. Development work at the Hollinger Consolidated is being speeded up to increase the amount of ore available for the mill, now running at half capacity. It is expected to be in full operation at an early date. Upwards of 40 machine drills are being operated, every level from the surface down to 1,250 ft. is being opened up, and approximately one mile of underground work per month is being accomplished. Everything points to a very heavy production during the year. Machinery has been brought in for the development of the Gold Lake property, which will be actively undertaken. The Davidson, at which extensive ore-bodies of good grade have been developed, is expected to become a producer shortly. This company has recently acquired control of the Bilsky property adjoining. Among companies temporarily closed down owing to labour shortage, which will resume operations if conditions continue favourable, are the Porcupine Crown and the West Dome. A rich strike at the McIntyre of ore averaging $60 to the ton on the 1,125 ft. level is reported.

KIRKLAND LAKE. — Production is well maintained by the Lake Shore, which during November recovered gold to the value of $44,578 from the treatment of 1,820 tons of ore, the mill working 95·5% of the possible running time. The Canadian Kirkland property has been purchased by D. H. Angus and George E. Drummond, of Montreal. A high price is said to have been paid. The directors of the Wright-Hargreaves propose to sell a block of treasury stock to finance the construction of a 150 ton mill. The mine is adjacent to the Lake Shore and has a continuation of its rich veins. The Ontario Kirkland, which is equipped with electrically-driven machinery, has planned extensive development down to the 300 ft. level. The 150 ton mill of the Kirkland Lake has been completed and is being run experimentally. The Teck Hughes has resumed milling operations on a limited scale, treating approximately 2,000 tons of ore during November. The mine has been developed to a depth of 600 ft.

BOSTON CREEK.—Great activity is looked for in this district during the coming season, as much additional capital has recently been attracted to it. The Cullen-Renaud and the O'Donald groups of claims have been taken over by the Allied Gold Mines, a newly organized company represented at Boston Creek by Robert W. Norrington. Diamond-drilling is being carried on at both groups and a contract has been let for the sinking of a shaft on the Cullen-Renaud on the continuation of a rich vein of the Miller-Independence. The shareholders of the Miller-Independence have authorized an increase of the capital from 500,000 to 700,000 shares to raise funds for the carrying out of an extensive development programme. The discovery of gold tellurides in large quantities is regarded as a highly encouraging indication of the value of the mine. As a preliminary step W. E. Simpson and Frank Groch, consulting engineers, have begun the work of thoroughly surveying and sampling the workings. The Fidelity Mining Company which owns a number of claims in Skead Township, lying just eastward of the Boston Creek area, is arranging to begin development at an early date.

COBALT.—The Nipissing during November mined ore of an estimated value of $281,078, and shipped products from Nipissing and custom ore of an estimated net value of $431,605. Its total production for eleven months ended November 30 was $3,290,672. In addition to its regular quarterly 5% dividend the company declared an extra bonus of 5%. A new vein discovered at the 200 ft. level of the Crown Reserve shows 3 to 4 in. of ore carrying 2,500 oz. to the ton. The Kerr Lake during November produced 169,000 oz. of silver, being a decline of 30,000 oz. as compared with the previous month. The Adanac has considerably increased its working forces. Rich ore has been encountered on the 310 ft. level and the mine will make regular shipments to the mill of the Dominion Reduction Co. Notwithstanding the boundary dispute with the O'Brien, the La Rose is steadily pushing development on the Violet property. The shaft had been sunk to the 470 ft. level, where the ore shows improved silver content. At the Gifford a vein of 11 in. cut at the 360 ft. level shows heavy mineralization. The Pittsburg-Lorrain mine in the South Lorrain district has been closed down.

The Coniagas report for the year ended October 31 last shows a decrease in the output of silver as compared with the year before, but this decrease is largely offset by the higher price of silver. The output was 974,264 oz., as against 1,344,276 oz., and the price per ounce was 79·89 cents, as against 63·11 cents. The total income derived from the sale of ore and of the products of the subsidiary Coniagas Reduction Company was $4,099,491. The dividends and bonus for the year amounted to 12½% on the capital, absorbing $500,000. No new discoveries of ore of any importance have been made lately, and the future depends more than ever on the low-grade concentrating ore, rather than on the rich ore that can be bagged in the mine.

DIVIDENDS DURING 1918.—The gold and silver mining companies of Northern Ontario returned dividends amounting to $6,311,477 during the year, not including the earnings of private corporations which would bring the total up to about $7,000,000. The total for 1917, including the profits of private companies, was $7,726,843. Twelve companies were in the dividend-paying class, 9 being silver and 3 gold mines. In 1917 there were 20 dividend paying companies, 15 being silver mines and 5 gold mines.

NORTH OF ENGLAND

February 8.

THE LEAD POSITION.—It were almost superfluous to say that the subject still uppermost in the minds of mine owners is that having reference to the refund and to the prices of the products that are mined. It is worth while perhaps to take stock of the situation which has developed. The Government gave notice on December 23, 1918, that the refunding of the award should cease on December 31. When Government control was lifted the price of pig lead was fixed at £40 per ton. The official view was that the increase in the price justified the termination of the award. There came immediately from all directions such a storm of protest that the Government eventually agreed that the refund should continue until January 31 to those mines producing a large proportion of blende as distinct from lead. Pending an interview between the Industrial Council of the industry and the Ministry of Munitions, blende was allowed to remain at the old price of £12. 9s. 9d. for 50% blende delivered at works. The interview took place on January 8. There were in attendance on one side the whole of the owners and trades unions' representatives; on the other Mr. Judd, of the Financial Department; Captain Cockerill, of the Mineral Resources Department, a representative of the Board of Trade, and several minor officials. It cannot be said that the attitude taken up by Mr. Judd revealed much regard for the economic situation of the industry, let alone much sympathy or understanding of the difficulties under which owners have laboured since the outbreak of war. It was sufficient for him that the price of lead at £40 was one that would amply cover the award. In vain was it pointed out to Mr. Judd that the Government was selling lead at the time at £35, and that the forward price was £30, which was equivalent to the control price of £29; that the Government had then 63,000 tons of lead in stock, the increase for the month being nearly 14,000 tons, and that with this large tonnage hanging over the market it was quite obvious there was no possibility of maintaining a figure of £40 per ton. Mr. Judd was impervious to argument, which gained important support for the men's side. Mr. Sherwood, of the National Union of Workers, was equally as emphatic as Mr. A. L. Onslow, who presented the case for the owners, in impressing upon Mr. Judd that the award was one which the industry could not pay, and that if it had to be paid the industry must necessarily have to close down. Mr. Judd was unyielding. It was made clear to the deputation that the Government wished to liquidate its stocks at the earliest moment, and that there was every chance the price might again have to be reduced. The Government is in fact now offering its stocks of pig lead to consumers at £30, a further reduction of £5 per ton.

Mr. Judd, indeed, went even further. The control having ceased, the Government had no more responsibility toward the industry. If expenses could not be met on the figures quoted in the open market, then the mines might just as well close down. Three hours' discussion had done nothing to break down ever so partially the official stand. It had served only to create a disagreeable impression that the Government recognized no moral obligation to an industry which seems to have been marked out for specially harsh treatment during the war.

The deputation decided then to approach the Board of Trade. They were vouchsafed an interview, and received a most careful and sympathetic hearing from Mr. Percy Ashley. He fully appreciated the seriousness of the position, and informed the deputation he was quite convinced that the Government should allow the refund to remain for a few months at all events. He promised to communicate a decision at the earliest opportunity. Notice has now been received that the refund will be continued until March 31. The respite so hardly won is exceedingly welcome. Unless it had been forthcoming the mines would have been obliged to pay the award in April and May. After that the mining companies will have to make such arrangements as are possible with their men. But there is little doubt that there will be a mutual accommodation between masters and men when the Wages Temporary Regulation Act ceases to apply to the scale in existence at the present time. The men have evinced a disposition to come to an amicable arrangement with their employers. It should be added that the Government, having found that the arrangement for the payment of a bonus on output is legally binding upon them, will carry it out until June 30. After that all subsidies and assistance will terminate.

ZINC MINES. — With regard to zinc, the position is still obscure. The mines at the present moment are compelled to sell to the Zinc Smelters' Association, but it is understood that as the Government is selling the concentrates they have acquired from Australia there will be a free market shortly. What the price is to be no one knows. If the Government determines to drop the price of the ore it may be supposed that the mines will have to accept a lower price. There is, however, this to be remembered. The English smelters do not care for Australian blende, and, as a matter of fact, have so far refused to enter into a binding agreement to take the Australian supplies. This appears to show that English blende is superior in quality to Australian blende. Mine owners certainly believe that the coarse English blende is better than the fine, dusty blende which has been imported from the colonies. Not without a considerable bearing upon the situation is the lowness of stocks of blende in Belgium and the anxiety of the Belgian Government to obtain large quantities before the end of the year. The Belgian zinc works have been practically destroyed by the Germans, and in most cases, if not in all, there is little chance of their resuming operations for five or six months to come. The home miners may find that it will be best to enter into negotiations with the Belgian smelters to take their products. In any event, however, the Lead and Zinc Mine-Owners' Association is confronted with so many difficulties that it is not easy to see why full co-operation is not secured among its members for the disposal of their products. Such co-operation is coming in other industries dealing in raw materials, notably in the case of hematite iron ore and pig iron, and there is no reason why it should not be practicable in the lead and zinc-mining industry.

THE CALDBECK DISTRICT.—The Carrock wolfram mine in the Caldbeck Fells in Cumberland is being closed down. Notice has been given to the underground men, and operations on the surface will cease as soon as the stocks of ore have been dressed. This step has been compelled by high costs, one of the most important of which is cartage. And in this connection it may be mentioned that a project has been launched for the building of an electric railway from the Cockermouth, Keswick, and Penrith railway to Carlisle via Carrock. Such a railway would facilitate the opening out of the very rich area of the Caldbeck Fells which fifty years ago was one of the chief producers of lead in the country. The blende at that time was not treated. There are large deposits there which could be worked if dealt with on modern lines.

CYANAMIDE MANUFACTURE.—The Nitrogen Products & Carbide Co., a London company which operates in Norway, is about to establish a similar industry at Workington. The company has acquired the St. Helen's colliery, and will carbonize all the coal. The gaseous and liquid products will be treated for the manufacture of sulphate of ammonia and raw materials for dyes, while the gas and coke will be used for generating electric power for the production of carbide and cyanamide. The coke will also be available for use in the electric furnaces.

CAMBORNE.

JOINT INDUSTRIAL COUNCIL.—On January 17, the Joint Standing Industrial Council for the Tin Mining Industry of the United Kingdom was formally inaugurated at a meeting held at Camborne, when Mr. Bertram Wilson, of the Ministry of Labour, attended to give it his blessing as representing that Government Department. The Council consists of 30 members, one-half representing the Employers' Federation and the other the Unions. The first Chairman is Mr. C. A. Moreing, of Messrs. Bewick, Moreing & Co., the general managers of East Pool & Agar, Ltd., and the Vice-Chairman, Mr. J. Harris, the district organizer of the Workers' Union. The employers' representatives include practically everyone of any prominence connected with the industry, while the employees have nominated their most able and trusted Union leaders. It is a strong combination, and we cannot but think that this organization has much scope for useful service before it. Mr. J. Vivian Thomas is acting as honorary secretary.

The first business of the Council was to give consideration to the proposal to ask the Government for financial assistance to enable the industry to tide over the abnormal conditions now ruling, and to press for a State inquiry as recommended by the Committee of Production and referred to in these columns in November last. This matter forms the subject of the succeeding paragraph.

STATE FINANCIAL AID FOR CORNISH MINES.—At last this question of State financial assistance for the industry, which has been talked about so long, has been brought to the attention of the Government by the Joint Industrial Council, who, on January 30, sent a representative delegation to meet the Parliamentary Secretary of the Board of Trade. This delegation consisted of Messrs. C. A. Moreing (Chairman of the Council), O. Wethered, J. Gilbert, C. V. Thomas, Major F. Oats, J. Harris, and W. J. Crowley (Workers' Union), J. R. Rowe (Dockers' Union), together with Harold E. Fern, acting as secretary to the delegation. It was urged that the Government should:

(*a*) Give the industry such financial assistance as would enable the mines to continue working during the period of reconstruction, (*b*) Institute a State inquiry into the position of the industry and its future prospects as recommended by the Committee of Production.

Briefly, the reasons given in support of these claims were that:

(*1*) The necessities of the State in the matter of labour for the Army and in the control of the price of tin have helped to bring the industry to its present parlous condition.

(*2*) The high prices of coal and materials—the former mainly due to increases in the wages of coal miners which have been authorized by the Government Coal Controller—have had a serious effect on the industry, and have prevented the tin miner from being paid a wage adequate to meet the increased cost of living.

(*3*) The price of tin for approximately the first two and a half years of the war was less than its pre-war selling price. The subsequent rise was checked by the Government control and reduced to such a figure that tin cannot be produced in Cornwall under existing conditions other than at a heavy loss, except in the isolated cases of abnormally rich lodes, or with the assistance afforded by the sale of the by-products, wolfram and arsenic.

(*4*) Government money is now being provided for out-of-work donations which could be spent to better advantage in another way.

(*5*) Unless the mines now working can be maintained, the labour employed must subsequently be thrown out of work, and no work will be available for the men now being demobilized, in which event it is clear that very large sums of money will have to be found by the State by way of unemployment donations.

(*6*) Recent inquiries by Government agencies—witness the Committee of Production and the Board of Referees—supported the claim for a State inquiry.

It is understood the Minister frankly admitted that a strong case had been presented, and one warranting immediate attention, and it is hoped in view of this that there will be no unnecessary delay in tackling the problem.

To judge from the reports, there would appear to be little doubt that the State inquiry will be authorized. But the more urgent problem is the financial aspect of affairs, for unless monetary assistance is promptly given in some cases, the need of the inquiry will be largely discounted. Once pumping is stopped and the pitwork ripped out, the mines are unlikely to start again. As to the form of the financial assistance, the two suggestions receiving the largest measure of support are a grant toward pumping cost, and the purchase for a period by the Government of the mines' output of tin concentrate at a fixed figure double that of the pre-war price, and on the lines of the wolfram contract. If the former is adopted, those mines where pumping charges are light will not benefit on anything like the scale of the central mines in the Camborne district. The purchase of the output is undoubtedly the simplest and most effective temporary remedy.

It appears that the Joint Industrial Council does not desire the assistance of the Member of Parliament for the Mining Division in securing Government assistance for the industry, if we are to judge by a recent speech of Mr. Acland's in which he bewails their refusal of his co-operation. Probably the labour members of the Council—who, we believe, are mainly responsible for this action—have longer memories than he gives them credit for.

OUT-OF-WORK DONATION.— While the Government grudgingly refuses to give any financial assistance to those mines whose unfortunate position has been created, presumably, by the necessities of the States, on the other hand it has no objection to paying "out-of-work" donations to men who have lost their jobs through the suspension of some of the mines, and incidentally, in some cases, to our personal knowledge, of subsidizing idleness. This dole amounts to 29s. per week, plus, in the case of a man with children, 6s. for the first child, and 3s. for the others per week, so that the man with a fair-sized family can secure more this way than by working. This costly scheme of out-of-work donations is evidently the best plan the Government could devise for getting over the difficulty, but we fancy that had an intelligent business man been consulted, a plan more satisfactory, at any rate to the mining industry of the West of England, could have been devised. For instance, this money in a lump sum would have assisted some of the mines to tide over these difficult times, and thus have provided work and raw materials which are needed for the reconstruction of civil industry.

MINES DEPARTMENT.—The agitation for the establishment of a Government Department to deal with all mining matters is the realization by the mining community that so long as several Departments deal with different phases of mining, so long will confusion reign supreme and the opportunity be afforded these different Departments of side-tracking reforms and new ideas, and of escaping responsibility by putting the blame on shoulders other than their own. Who has not had the depressing experience of being referred from one Department to another until one has given up in disgust any hope of finding the official who really has authority to deal with one's grievance? Sir Lionel Phillips tackled the problem in his report, referred to recently in these columns, and others have before him, but the movement to be successful needs the combined support of the whole of the mining interests of the United Kingdom. And if a Mines Department, when established, is to be of service to the mining industry as a whole, it must not be run solely in the interests of coal mining, which, of course, is the principal class of mining in this country; a separate section should be established to deal with metalliferous mining.

WORKMEN'S COMPENSATION (SILICOSIS) ACT, 1918.—This is an Act which was passed through Parliament in July of last year, but of which little notice seems to have been taken in Cornwall. Powers are given the Secretary of State to inaugurate a scheme to provide, in any specific industry involving exposure to silica dust, for the payment of compensation by employers to workmen who are certified to have suffered death or total disablement from the disease known as fibroid phthisis or silicosis of the lungs, or from that disease accompanied by tuberculosis, or to workmen, who, although not totally disabled, are found on medical examination to be suffering from the disease to such a degree as to make it dangerous to continue work, and are for that reason suspended from employment. It is specifically provided, however, that in a case of silicosis accompanied by tuberculosis, provision shall not be made for the payment of compensation unless the silicosis was so far advanced as to make the workman specially liable to tuberculosis infection, or, though not so far advanced, was likely to accelerate materially the progress of the disease. The scale of compensation is that prescribed by the Workmen's Compensation Act, 1906, and any subsequent enactment. No order under the Act has so far been made to apply a scheme for the tin-mining industry of Cornwall and Devon, but Mr. Brace, in introducing the Act, specifically mentioned that industry as one that was affected thereunder. [Probably the reason the Act has been overlooked in Cornwall is that when the bill was introduced stress was particularly laid on its application to the fireclay, firebrick, ganister, and refractories industries. In the Magazine for July last reference was made to the bill entirely from this point of view.—EDITOR.]

SOUTH CROFTY.—Last month a lode of good width and payable values was intersected in the bore-hole being put out north at the 290 fm. level. This lode is believed to be one of the East Pool north series, which in that mine have proved rather patchy. However, it is obviously a promising discovery, which will doubtless be developed at the earliest opportunity.

LEVANT.—The effects of the strike in August last are still being felt at this mine, and are reflected in the statement of account which has been issued to the adventurers for the 16 weeks ended January 11. This shows that only 2,361 tons of ore, or about 40% of the normal quantity, was milled, producing 59 tons of black tin, or the very excellent recovery of 57 lb. per ton. When it is remembered that owing to the accumulation of water in the bottom of the mine, through the cessation of pumping at the time of the strike, no ore was mined below the 278 fathom level, it is encouraging to see so high an average grade of ore still available in the upper workings. It looks as though in some respects the strike may prove a blessing in disguise, for the development work carried out of necessity in the upper levels has given these satisfactory results. For the period of this account, a loss of £1,856 was made, and but for the fact that the company is working under the cost-book system of unlimited liability, the financial position would not be regarded as particularly strong. Capital is badly needed for shaft sinking, development, and the installation of transit facilities underground, but the present condition of the industry in general has doubtless decided the executive that this is hardly the time to convert the company into one of limited liability, and to make an appeal for funds. We believe that this famous old mine would respond well to any capital outlay of this character. A notable feature of this account is that, since the last meeting, a further £3,000 has been invested in 5% War Loan, and an overdraft created with the company's bankers of £2,234; this does not appear to be good business on the face of it. The number of employees is now 251; before the strike the mine employed 336, so that clearly all the men were not gainers by the dispute.

WHEAL KITTY.—This mine closed down on January 25 after having worked continuously since 1838, and having produced well over one million pounds' worth of mineral, principally tin. It will be remembered that the late J. H. Collins in 1904 acquired a controlling interest in this mine and subsequently a company was formed with a capital of £35,000, and although hampered by insufficient funds for development, small dividends were paid for several years. In July, 1916, the debenture holders took possession, and Mr. Harold E. Fern was appointed by the Court as receiver and manager on their behalf. Up to March, 1918, he operated the mine at a small profit, in spite of the reduction of the staff from 220 to less than 100, and in spite of the high prices of coal and other materials. In March, 1918, a breakage occurred to the polecase at the 540 ft. level in Sara's shaft, and before it could be replaced, the water was well over it. In view of the heavy cost to recover the lift, it was then decided to temporarily abandon the Sara shaft workings and put the men to work above the adit level in the Wheal Vottle section. For the time being, both ends were met, but with the reduced price of tin, this low-grade ore could not be operated at a profit, and in the absence of the necessary capital, there was no alternative but to suspend work. We are informed that at the time the breakage in the pitwork occurred, the Stamps lode at the 590 fm. level assayed 178 lb. per ton over a width of 15 inches, and there seemed every prospect of opening up a very profitable section of stoping ground. As it is not unusual to be told, when the water in a mine prevents examination and verification, that a splendid lode was left there when the mine closed, it is satisfactory to know in this case that the engineer of the Ministry of Munitions visited the mine just prior to the accident and his report confirms the statement of the management. It appears that there is still some hope that operations will be recommenced, as an option for the sale of the mine and machinery has been granted, and a deposit paid.

SUBSTITUTES FOR TIN.—The high price of tin last year led to the use of substitutes. In particular, it has been found that the use of cadmium as a substitute for tin in the manufacture of bearing and anti-friction metals, white metals, and solders, has been found to give fairly satisfactory results, cadmium being alloyed with lead and zinc in different proportions according to the particular use for which the alloy is to be employed. As every metallurgist is aware, cadmium lowers the melting point of alloys, and is therefore particularly suitable for producing fusible alloys and soft solders. It is of interest to note that, in the United States, it is officially suggested that a research laboratory should be set up with a view to ascertaining exactly how far cadmium can be used as a substitute for tin, as well as for the purpose of discovering new uses for the metal. The principal present source of the supply of cadmium is Upper Silesia, but it could be produced in fairly large quantities in other zinc districts, especially in America.

PITCHBLENDE IN DEVONSHIRE.—Paragraphs have appeared in the daily press announcing the discovery of pitchblende on the Kingswood estate, Buckfastleigh, South Devon. The announcements are vague but flamboyant, and savour of ignorance and artfulness combined. Pitchblende has not been reported from Devonshire before, but there is no reason why it should not be found there. Buckfastleigh is on the killas near the Dartmoor granite, and lodes of copper and other sulphides have been worked in the neighbourhood. We await more precise information relative to the discovery.

NEW CAMBORNE COMPANIES.—In September last, reference was made to two new projects which were contemplated, subject to Treasury consent. This latter was subsequently secured, but difficulties of one kind or another have delayed the registration of the companies until this month. The Tolgus Mines, Ltd., has now been registered with a nominal capital of £80,000, but there will be no public issue of shares. The working capital will be provided by East Pool & Agar, Ltd., the London Australian & General Exploration Co., Ltd., and the Californian Exploration Co., Ltd., while the management will be in the capable hands of Messrs. Bewick, Moreing & Co. The directorate is exactly the same as that of East Pool & Agar, Ltd., and the registered office of the company will be at East Pool. The company acquires the Great South Tolgus and the South Tolgus setts, through which runs the eastern extension of the famous Rogers lode, which has been developed so successfully in the Agar section of the vendor company's mines. The plan for testing this lode in the Tolgus properties was outlined in the September issue. Dr. Maclaren has a high opinion of the prospects c finding good tin values in Tolgus, and if hi anticipations prove correct, shareholders i East Pool & Agar, Ltd., will be on velvet, fc that company will have a large interest in th new venture without having made any ver great capital expenditure.

The other registration is Tehidy Mineral Ltd., with a nominal capital of £100,00 This company acquires from Dolcoath Min Ltd., and East Pool & Agar, Ltd., certai mineral areas in the heart of the Camborn district and which form part of the Tehid estate acquired some time since by those tw companies. We understand the company wi test and develop these properties, under th direction of Messrs. Bewick, Moreing & Co and subsequently float off those which warran such a course. This is also a speculation c great promise, and it will be surprising if on or two plums are not found in this highl mineralized area, part of which has never bee worked because the then owner of the estat Mr. Basset, would not permit the view fro his house to be spoilt by mine dumps an buildings. It is evidence of the confidence c the promoters in this undertaking that the have underwritten the working capital at time when Cornish mining is under a clou Forty thousand shares are to be offered fc subscription to the shareholders in Dolcoat Mine, Ltd., and East Pool & Agar, Ltd., an we have confidence that they will be taken b those who know the history of the district an its possibilities.

BODITHIEL SILVER-LEAD.—A compan has just been formed for the purpose of work ing the Bodithiel silver-lead lode in the S Pinnock district, south-west of Liskear There are many lodes in this part of Cornwa containing sulphide ores, in some places con taining also important amounts of spathic iro ore. Particulars are given in J. H. Collins' "Observations." The capital of the ne company is £12,500 in shares of 5s. eac and the agreement to acquire the property i made with the Anglo-Peruvian Finance Com pany, Limited, Baron Thomas de Ward, an E. N. Fellowes. The registered office is Great Winchester Street, London, E.C.2.

GEEVOR.—In the issue of October last i was mentioned that the Geevor would be re quiring further capital in order to expand th scale of operations. Treasury consent ha now been granted for the new issue, and b the time this paragraph appears in print offer of 60,000 shares of 10s. each will be made t shareholders and the public.

PERSONAL.

A. D. ARMSTRONG has joined the staff at the steel works of the Broken Hill Proprietary, at Newcastle, N S.W.

BAINBRIDGE, SEYMOUR & Co., of Salisbury House, London, E.C.2., have rearranged their business as a private limited company for the purpose of conveniently defining interests. This is one of our oldest firms of mining engineers and mine managers. With their managing director, MAJOR J. W. TEALE, D.S.O., back from the war, an increase of their activities may be expected.

CAPTAIN H. B. BATEMAN, R.A., is returning from British East Africa.

LINDESAY C. CLARK, general manager of the Briseis Tin & General Mining Co., has been commissioned by the Victorian Government to report on the best method of mining the Morwell brown coal deposits.

F. G. COTTRELL has been awarded the Perkin medal by the American Chemical Society in recognition of his work on electrostatic precipitation of fume and dust.

W. CRAIG has been elected president of the South African Society of Civil Engineers.

E. R. CRUTCHER, formerly with the Anaconda, recently joined the staff of the Mount Read & Rosebery Mines, Ltd., and is engaged in an investigation of the ores and the design of an electrolytic zinc plant.

STUART STRICKLAND MOORE EDE, consulting electrical engineer, has joined the board of Johnson, Matthey & Co., Ltd.

A. J. EVELAND, of the American Zinc, Lead, & Smelting Co., has gone to Mexico City.

SYDNEY E. T. EWING has been appointed representative of West Springs, Ltd., in the Transvaal Chamber of Mines.

DR. J. D. FALCONER, lecturer in geography in Glasgow University, is to be the first director of the Geological Survey of Nigeria. His book on the Geology of Nigeria is well known.

SEC.-LT. J. A. L. GALLARD has received his discharge from the Army and is resuming his position as mining editor of the *Financial Times*.

HENRY HOOKE has resigned as Senior Inspector of Mines to the New South Wales Government and is coming to London on professional business.

LT.-COL. H. H. JOHNSON has gone to Kirkland Lake.

R. H. JOHNSON is returning to England from Nigeria.

EDWARD K. JUDD has resigned as editor of the *Bulletin* of the American Institute of Mining Engineers and has joined the staff of the American Metal Company.

LT.-COL. H. W. LAWS, D.S.O., of the firm of Laws, Rumbold & Co., lately Controller of Mines, 3rd Army, has left the army and has returned to London

CECIL LEIGH, lately chief chemist for the Birmingham Metal & Munitions Co., Ltd., has been appointed general manager for Thermit, Limited.

LT. OWEN LETCHER, on the conclusion of his duties in East Africa, has resumed his position as mining editor of the *South African Mining Journal*.

MICHAEL H. LOVEMAN, recently chief geologist to the Burma Corporation, has opened an office at 32, Broadway, New York.

LT.- COL. T. M. LOWRY, M.C., D.S.O., is a member of the Imperial War Graves Commission.

SIR FREDERICK LUGARD is resigning as Governor-General of Nigeria. He was High Commissioner of Northern Nigeria from 1899 to 1906, and from the latter date to 1912 he was Governor of Hong Kong. He returned to Nigeria in 1912.

CAPTAIN J. M. MATHEW has joined the metallurgical staff of the Electrolytic Zinc Company of Australia at Risdon, Tasmania.

T. H. PALMER has resigned as manager of the Junction North mine, Broken Hill.

A. E. DU PASQUIER has been elected president of the South African Institute of Electrical Engineers for the current year.

CHARLES P. PERIN, the American engineer connected with the Tata iron industry in India, has been appointed assessor of damage done to the Belgian and French iron mines and steel works during the German occupation.

EDGAR RICKARD has been in Paris and London, and returned to New York on February 12.

P. A. ROBBINS, lately manager of the Hollinger at Porcupine, has opened an office as consulting engineer at Hobart Building, San Francisco.

LT. W. R. RUMBOLD is at Jos, Nigeria.

CAMPBELL SHAW has resigned as manager of the Edna May Deep Levels, West Australia, and is succeeded by N. S. STUCKEY.

WILTON SHELLSHEAR has returned to Australia from Burma

L C. STUCKEY is expecting to sail this month for New York on his way to the Mazapil copper mine, Coahuila, Mexico.

ARTHUR L. SWEETSER has joined the editorial staff of the *Engineering and Mining Journal*.

M. T. TAYLOR, manager of East Pool & Agar, is recovering after a serious operation.

H. L. VENABLES is expecting to return to South America next month.

G. T. VIVIAN has joined the metallurgical staff of East Pool & Agar.

EDGAR T. WHERRY has been appointed editor of the *American Mineralogist* in succession to W. G. Levison.

H. E. WHITFELD, professor of mining in the University of Western Australia, is intending to return to Australia shortly. For three years he has been doing war duty for the Ministry of Munitions, both in this country and in the United States.

WILLIAM WHYTE is acting-manager of the Messina copper mine, Northern Transvaal, during the absence of the manager, A. B. EMERY.

R. WILLIAMSON has been appointed manager of the Misima gold mines, Papua.

HORACE V. WINCHELL has been nominated for the presidency of the American Institute of Mining Engineers.

The Geological Society's awards are as follows: Wollaston Medal to SIR AUBREY STRAHAN, director of the Geological Survey of England; Lyell Medal to DR. W. F. HUME, director of the Egyptian Geological Survey; Bigsby Medal to SIR DOUGLAS MAWSON; Woollaston Fund to DR. A. L. DU TOIT, of the Geological Survey of South Africa; Lyell Fund to JOHN PRINGLE and DR. STANLEY SMITH.

E. J. MOYNIHAN, an independent consulting engineer, of Johannesburg, died in December.

DR. G. S. CORSTORPHINE, principal of the South African School of Mines and Technology, and a leading South African geologist, died on January 25. In this country he is known as co-author with Dr. F. H. Hatch of "The Geology of South Africa."

JAMES PAUL JOHNSON died at Johannesburg in October last from pneumonia, following an attack of influenza. Mr. Johnson was born in London in 1880, and was educated at Dulwich College and the Royal School of Mines. In 1902 considerations of health compelled him to emigrate to the Transvaal. On the outbreak of the war he was living in Tasmania, where he intended to settle, but returned to South Africa. At an early age Mr. Johnson was a student of the Pleistocene deposits of England and of stone implements, and several papers were contributed by him to various societies and magazines dealing particularly with Essex geology. In South Africa he found an almost virgin field for his line of research, and the results of his work were embodied in "The Stone Implements of South Africa," "Geological and Archæological Notes on Orangia," and "The Prehistoric Period in South Africa." In his capacity as a mining geologist, he wrote "The Mineral Industry of Rhodesia" and "The Ore Deposits of South Africa."

THE LATE JAMES DOUGLAS.—James Colquhoun writes in most appreciative tone of his old friend James Douglas in a recent issue of the *Engineering and Mining Journal*. Mr. Colquhoun was for many years the manager of the Arizona Copper Company, and was a co-pioneer with James Douglas in the development of copper mines in the South-West. He has retired from active mining and lives at Tunbridge Wells. We quote him nearly in full. "It was as the professor that I first knew him, and it is as the professor that I, like other old timers, prefer to remember him. He went to Arizona in 1882, I a year later; and there we worked side by side for more than 20 years. I cannot recall the day when first I saw him, but we soon became friends, and we maintained an unbroken friendship to the end. He was older than I was, and more experienced, yet he never presumed on that account. His views were presented with a modesty which never deserted him, and a moderation which was at once a lesson and an example. His early training and the personal influence of his noble and self-sacrificing father had left a note of seriousness in his character, but he could unbend on occasion, and could give and take when wit and humour held the field. He never failed, if within reach, to attend my annual dinners, always as the most honoured guest. His speeches, reminiscent of old times and old timers, were always instructive and enjoyable; and he was just as eager to listen and as ready to enjoy the flow of humour which is characteristic of the West and of Western men. His outlook was as wide and as far-reaching as his knowledge, and his knowledge was profound. He spoke well on any subject, and he never failed to command the interest and sympathy of his audience. He had none of the finish and style of the trained orator. In speech he was plain, direct, and unaffected. His strength lay in his good heart, in his sincerity, and in his desire to spread the light of knowledge. Always he pleaded with us for the exchange of experience between the various mines and metallurgical plants. Like the father of us all, as he was in a sense, he passed from one camp to another, a carrier of good will and an example of bright and generous thinking. It was to me he first came with the proposal that our companies should agree to the side-line boundary. That the agreement was consummated with such happy results to both parties was due as much to the influence of his lofty character as to the soundness of his arguments. He was always my guest when he found his way to Clifton, and no guest was more gladly welcomed. In his own inimitable way he made himself one of the family. He loved children, and so young was he in spirit that he would join with them in their games. Once I found him in a deadly football contest with my two little boys. The boys had challenged him, and he had promptly accepted the gage. They selected the parlour for the field of battle, and there, to my dismay, I found them hotly engaged, quite regardless of the consequences to the furniture, windows, and bric-à-brac. I stopped the game on the plea of rough play, and the professor appeared to be even more disgusted with the decision than were his opponents. When the Morenci Southern was building, the engineer acting for the company let a contract to the Mormons for the removal of alluvial soil. When the Mormons entered upon the contract, however, they found that for more than a mile this alluvial soil had been cemented into a hard conglomerate, which could not be moved with anything short of giant powder. There was consternation in the Mormon camp, and my friend, President Kimball, their worthy head, came to me and requested that I use my influence to right the wrong. I advised him to go to the professor, but, like others before him, he did not care to beard the Douglas in his den. I finally consented to write to the professor, and the matter was promptly arranged in the right spirit, much to the relief of the Mormons, the professor remarking, in his dry way, that geology sometimes overshot the mark. Shortly before the war I met the professor in London. I had not seen him for years, and our meeting was to me a very great pleasure. He was not a day older in spirit. We drove through Walbrook, a narrow lane, and found the way blocked by a beer wagon, anchored to which were two powerful horses. In a moment, and before I could interfere, the professor had the horses by their heads and had led them to a wider space, leaving room for our taxi to pass. The driver came out, wiping the froth from his mouth, and getting ready to swear, but a look at the professor's triumphant and smiling face was enough. No one could swear at the professor. We agreed to revisit the old scenes in Arizona at some early date in the future, but alas! that pleasure was not to be. Some one described the professor as the James Bryce of Arizona. I do not agree, although I admit a resemblance. Man of letters the professor undoubtedly was, but he will be remembered not as the historian but as the great captain who more than any other man helped to make Arizona what it is. He had the gift of attracting and holding brainy men, who served him with that splendid loyalty which only the true chieftain can command. It was an essential part of his policy that the happiest relations should be maintained between the employees and the company. He was one of the first to recognize that the interests of the employee and the interests of the employer are identical, and not in conflict, and through foul and fair weather he adhered to that principle. He loved the West and he loved the ways of the West. In the depths of the mine, watching the development of new ore-bodies, or at the metallurgical plant contemplating and discussing the most recent improvements, he was in his element and at his best. As I recall him now, with all his endearing traits of character, I feel that without him the West will never be quite the same to me. But his spirit—his broad, tolerant, and kindly spirit—will go marching on from generation to generation, making for progress and prosperity, preaching charity to all and malice to none. The professor has gone West; he has crossed the great divide, and there let us hope that by God's kindness he found awaiting him some of the boys who had gone before, some of the boys who, true to his teaching, had given proof on the battlefield that there are some things in this world more precious than life itself.

TRADE PARAGRAPHS

JOHN M. HENDERSON & Co., King's Works, Aberdeen, send us their calendar for 1919, which illustrates their specialties in aerial ropeways and other hoisting and transporting machinery.

THE MAGNETIC MANUFACTURING COMPANY, of Milwaukee, Wisconsin, send us several bulletins relating to magnetic separators and magnetic pulleys. These are intended for the collection of iron and steel scrap from workshops, and for removing iron and steel fragments from raw materials, such as ore, before going to treatment plant.

THE WOLF SAFETY LAMP CO. (WILLIAM MAURICE) LTD., of Young Street, Sheffield, send us their general catalogue of acetylene lamps which are extensively used in mines and other places. The list includes some new specialties introduced by Mr. Maurice. The firm also make electric safety lamps for mines, using both lead and alkaline accumulators.

The business of the firm of GERHARD & HEY, LTD., shipping agents, of Great St. Thomas Apostle, London, E.C.4., was greatly restricted and hindered by war conditions. Since the Armistice was signed they have made arrangements for an expansion. The firm is well known among mining men as specialists in the shipping and transport of mining plant and supplies.

THE MYERS-WHALEY CO., of Knoxville, Tennessee, U.S.A., send us the latest bulletin describing their shovelling machines. These shovels dig the ore, stone, or other loose material and tip it behind on to a continuous travelling belt or conveyor which delivers it into a car at the back. The machines, including the conveyor as an integral part, are made so that they occupy little head room, and they can therefore be conveniently used in mines as well as on the surface. Mr. F. A. Perry, of 63, Queen Victoria Street, E.C.4, is the London representative of the company.

THE NEW JERSEY ZINC COMPANY announce that their general offices have been removed to 160, Front Street, New York. This is a new building which has been erected for their exclusive use. The structure is seven storeys high, of brick construction, and fireproof. Excellent working conditions will prevail in the company's new home. Every modern convenience has been installed for the comfort of the employees, including luncheon and rest rooms. A demonstration room, a library, and a museum are provided, and also a permanent exhibit of the company's products.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., LTD., of Cambridge, send us particulars of their Flow Recorder, used for recording the volume of gas or air passing through a pipe. This meter is intended primarily for the measurement of large quantities of gas or air under conditions for which other methods are either unsuitable or too costly. It finds its greatest field of usefulness in connection with coke ovens, blast-furnaces, and large producer plants. It has been employed with success to record the total quantity of air passing through the shaft and galleries of mines and collieries. In gas works it has proved of assistance in controlling the distribution of gas throughout an extensive system of mains, and in the adjustment of the proportion of water gas added to the gas supply. The apparatus consists of a Pitot tube in conjunction with a sensitive differential pressure gauge which measures the velocity of the gas passing through the pipe, and from which the volume of gas can be determined. For speeds greater than 20 ft. per second it is accurate enough for industrial purposes. Balanced inside the body of the meter, which is filled with water whose surface is covered with a non-volatile liquid, is a large bell-shaped float to which a pen rod is directly connected. The upper tube projecting from the side of the instrument enters the space above the float, while the lower tube projects into the space below the float. The difference in pressure between the inside and outside chambers determines the position of the float, and consequently of the pen rod. The chart drum makes one revolution every 24 hours. The charts are usually 8 in. high and 25 in. long, and are printed specially for each recorder to read either speed in feet or volume in cubic feet, or the equivalents in the metric system, per second, per minute, or per hour. As nothing passes through the meter it can deal with hot and dirty gases without difficulty.

The winding engine at the New Modderfontein circular shaft is of the Ward-Leonard type, with two motors direct-coupled to the main shaft. The maximum speed of the motor is 53 7 r.p.m. The drum is single cylindro-conical, made of cast steel, with grooved treads for 2 in. diameter rope The diameter of the large cylindrical portion is 24 ft., and of the small cylindrical portion 15 ft. The conical portions are of the scroll type, taking the rope from the 15 ft. diameter in five turns. The maximum horse power is 5,140 b.h p. The machine is designed to lift a total weight, including rock, truck, and cage, of 32,000 lb., and about 22,000 lb of rope, from a depth of 2,220 ft. The makers of the mechanical portions were FULLERTON, HODGART, and BARCLAY, LTD., of Paisley, and of the electrical portion the GENERAL ELECTRIC CO., of Schenectady, New York. Whitmore automatic brake engines, automatic accelerating and retarding devices, and automatic overwinding gear are fitted.

THERMIT, LIMITED, of 675, Commercial Road, London, E., are makers of Thermit, the welding compound, and they use it in the manufacture of a number of refractory metals and alloys. The whole of the shares of the company are held by NOBEL'S EXPLOSIVES CO., LTD. They issue the following pamphlets: Instructions for welding of rails; Instructions for welding of pipes; General repair work; Locomotive repairs; Pure metals and alloys free from carbon; Titanium Thermit for foundry work; General description of applications. Mine managers generally keep a Thermit outfit for repairs of broken shafts and similar fractures. The pamphlet gives the following instructions: The pieces to be welded should be ½ in or more apart, in order to allow the molten metal to flow in between as well as around the fracture. The ends are thoroughly cleaned, and a wax pattern is formed round the fracture to the shape of a segment of a circle, the thickest part being in the centre of the weld. Mould boxes are then fitted, and the moulding sand—which should be good steel-foundry sand, capable of withstanding high temperatures—is tamped round the wax pattern, the runner and riser being formed in the usual way. A hole should be provided near the bottom of the wax pattern, through which the wax is melted out; an efficient heating torch is then applied to this hole, and the part to be welded is brought to bright red heat. The hole is then plugged with a dry sand core. The crucible is placed in position over the runnner, and charged with the welding compound, usually together with 15 or 20% of steel punchings. This welding compound is ignited by means of a special powder and a flaming vesta. Combustion quickly spreads through the entire mass without further supply of heat from outside source, the result being pure steel and slag—both in superheated liquid form—the slag being three times the volume of the metal but of equal weight. About thirty seconds from ignition are required to complete the reaction. As soon as the reaction is completed, the molten steel is run into the mould. After cooling, the runner and riser are cut off. Where possible it is always advisable to leave a band of Thermit round the weld, but if necessary this may be partly or even entirely machined off. The Thermit process can be applied to the making of small castings, especially for emergency work. Such castings are not brittle like iron, but tough, and stand up to wear exceedingly well. For the manufacture of such castings, 40 to 50% of mild steel punchings may be added to the compound, thus reducing the cost per pound of steel considerably. Flaws in castings can also be made good. The superheated steel fuses the metal and amalgamates with it to form a perfect filling of the hole, and not, as with so many compounds, merely a concealment of imperfections. The metals and alloys made by the Thermit, Limited, are free from carbon. The following are the most important : Chromium, ferro-chromium, manganese, manganese-copper, ferro titanium, ferro-copper, and cobalt. "Sab" is a special alloy made only by the company, used for producing a brass of high tensile strength and possessing great resistance to sea and mine water.

ROBEY & CO., LIMITED, Globe Works, Lincoln, send us their catalogue No. 239 dealing with air-compressors. The firm make a variety of types, horizontal and vertical, steam-driven and electrically driven, two-stage and single-stage. Though they make machines of both horizontal and vertical types, they are in favour of the horizontal type. We quote the statement of their views on this subject, contained in the catalogue, as it forms an interesting contribution to a standing controversy : "*Space Occupied*.—Here undoubtedly the vertical has an advantage over the horizontal, but in large sizes the great height of the vertical type necessitates costly buildings from the ground. *Foundations*.—In this respect there is not very much to choose between the two, because while the horizontal engine may require somewhat greater length, the vertical undoubtedly requires heavy foundations, to prevent the vibrations which are set up being transmitted through great distances and causing annoyance. *Weight for Shipment*.—In large size compressors the parts for transport can be made as light in the horizontal as in the vertical type. *Accessibility*.—In this respect the horizontal has a great advantage over the vertical, as in the former case all working parts are visible and accessible, while in the latter type everything has to be taken for granted until a smash takes place. When the air cylinders are superposed on the steam cylinders as in the vertical, it will be readily seen that the examination of the steam cylinders is a work of time. *Fly-wheel*.—With the comparatively high piston speeds of present day horizontal engines, the flywheel is no longer of cumbersome dimensions, and while the vertical engine has a smaller flywheel, it is generally made in one piece, so that the heaviest weight to be handled does not differ materially in either case. At slower speeds when less air is required, the more even turning of the horizontal type is most marked, the flywheel effect varying as the square of the speed. *Lubrication*.—While in the vertical type the lubrication must be of the forced type, in the horizontal type, the bearing surfaces being greater in proportion, this is not required, thus very much minimizing the risks of a stoppage due to a failure of the pump. *Durability*.—It may be safely stated that, in a horizontal compressor with properly designed surfaces, the durability is greater than in the vertical. Owing to the inaccessibility of the working parts in the latter, the necessary small adjustments, which can from time to time be so easily carried out in a horizontal compressor, are neglected in a vertical, until considerable wear has taken place requiring extensive overhaul. *Efficiency*.—In this respect the horizontal type cannot be beaten, because the most economical type of valve gear can be used. Where superheated steam is used, the adoption of the drop valve is rendered an absolute necessity if durability and low upkeep costs are desired, and this gear can be best adapted for use in a horizontal type. In the vertical type, the only class of valve that can be used is the common slide or piston with a fixed cut-off and a throttle governor, which gives very much less economical results in steam consumption than a high class drop-valve gear. *Reliability*.—While vertical high-speed engines are now far more reliable than they were previously, yet, for day and night work all the year round, it may be stated that the horizontal slow speed type has demonstrated its claim to the greatest reliability under all conditions. When it can be shown that a large horizontal drop-valve engine can run for ten years without costing a single penny in repairs, it will be seen that reliability must have been concurrent with this fact. Many drop-valve engines have been running over twenty years without requiring anything but small repairs and adjustments, and we have known cases where the cylinders even have not been examined for five years at a time. It will be seen from the foregoing that practically the only advantage the vertical compressor has over the horizontal is the occupation of a smaller floor space. We believe that this advantage will be considered to be very much outweighed by the greater number of good points in favour of the horizontal slow speed. It is worthy of note that in the case of winding engines, on the reliability of which the lives of men depend, the horizontal engine reigns supreme."

METAL MARKETS

COPPER.—Among the interesting events in this market during the past month has been the publication of the stocks held in this country by the Government, which are of course exclusive of old metals and scrap. These amounted on January 1 to 36,000 tons, and, comparing with the figures published as representing the stocks at the beginning of the previous month, it is seen that an increase has taken place amounting to 8,470 tons. This, although a pretty big stock, has not had any serious effect upon the market. Values, it is true, have been easier, but the cause of this seems to be more due to the freer offerings of copper from America. Meanwhile, however, it is obvious that stocks in the country are ample for all requirements, and the tendency has been for consumers to proceed in a conservative manner with their purchases. So long as the present labour unrest continues, manufacturers are naturally not over keen on increasing their commitments, while at the same time the reversion of industries from war to a peace footing takes longer than people are sometimes inclined to suppose. The general result, therefore, of the various factors in the situation has been a quiet market. One exception perhaps in this respect is manufactured copper, for which a fairly good inquiry has been seen, particularly for locomotive work, and hammered work generally. Up to the present, business with India has not been on any very important scale. Cable delays are doubtless partly responsible for this, but in addition buyers abroad seem reluctant to pay the high prices which prevail at present. So far as the standard market is concerned, business has not really developed on any very important lines as yet, although it is gratifying to see a growing interest in that market. This interest is for the most part confined to forward delivery, presumably owing to the lack of stocks available for prompt. However, it is understood that some increase in this respect is now taking place. Values have declined, principally in the price of near-delivery metal.

In America the market generally has been weak, owing of course to the cessation of war's demand and the tardy manner in which peace-time requirements are making themselves felt. Values consequently have declined down to below 20c. per lb. The principal event of importance, however, in this market has been the decision radically to cut down the output of the metal. Some mines are reducing to the extent of 50% compared with last year's output, and the general result will be a very much reduced production in the current year. In South America matters have not been looking too cheerful; a serious strike occurred at Lima, which affected the copper industry there. It was reported that the strikers had blown up the power-transmission line of the Morococha properties belonging to the Cerro de Pasco Co., and it was reported that the copper mines were being flooded. On the other hand, there are more favourable features. One of these is an indication of an improvement in the South American mining centres now that ocean freight seems to be obtainable more readily. One result of this is seen in the increased output for November of the Chile Company It is stated that this improvement may be expected to extend to other South American mines. It is reported meanwhile that the costs at the Lake mines are advancing. The Calumet & Hecla, for instance, returns its costs last year at about 13c. per lb., the Isle Royale at 15¾c., and the Osceola and Allouez at about 13⅞c. It is understood however that it is the intention of producers to re-establish the sliding scale of wages, which presumably will reduce wages and lower costs, in view of the lower market for the metal.

Copper ores containing from 15% to 25% copper are valued around 16s. 3d. to 16s. 9d. per unit according to quality.

Average prices of cash standard copper: January 1919, £93. 9s. 9d.; December 1918, £116. 5s.; January 1918, £110. 5s.; December 1917, £110. 5s.

Our imports for December were 12,206 tons against 19,267 tons in 1917, making for the year 1918, 203,943 tons against 142,778 tons.

TIN.—This market, unlike most others among the non-ferrous metals, has improved in tone during the past month, and a very active business has been seen almost daily on the London Metal Exchange. While the top figures touched have not been maintained, there still remains an advance on balance. Possibly one of the chief reasons for this has been the report that the Government of the Federated Malay States had decided to assist the local mining industry by taking over the ore output at a price which would approximate the parity of rather under £250 c i.f. London. This naturally has had a stabilizing effect, and the market in the Straits appears to remain steady, although news comes to hand rather sparsely while cable delays frequently make advices late. Stocks of the metal in this country are not yet on any very important scale, nor is there any promise of their being increased to any important extent in the immediate future. Consequently the covering of open prompts by bears who had previously put out sales has also helped to keep the situation firm. The demand from consumers has not been on any very big scale, but a steady inquiry comes along. Meanwhile the demand for English is quiet, and although some export licences have been granted, it would appear that these would need to come out more freely if a really active market for this grade of tin is to be stimulated. It is understood that permits to ship to Canada are being refused, this being presumably for the purpose of assisting the United States by diverting Canadian demand to that country. How the buyers in Canada will enjoy paying the American parity of prices, however, is another question. In the meantime no way out of the difficulty regarding the stocks in America seems to have been decided upon, so far as news reaching here goes. Various reports as to suggestions for importers or consumers to take these stocks over have been mentioned, without apparently any tangible result as yet. The market therefore in that country continues at much above the level of values ruling here, and consuming business appears to be very quiet, buyers naturally withholding their orders as long a time as possible in the hope of brighter prospects coming in view in regard to prices. Some discussion has taken place in the United States with regard to the position of Bolivian pig tin and Bolivian tin concentrates. It appears that an embargo has been placed on imports of the former while the latter comes in freely, and can be smelted into tin in the United States at a comparatively low figure (around 50c. has been stated). Meanwhile the Government maintains the price of tin at over 70c., which is obviously much to the advantage of these local smelters. Reports in regard to the Chinese tin trade are now to hand applying to the first part of 1918. This period, so far as Hong Kong prices are concerned, was considered a record. At the beginning of the year the local stocks were about 1,500 tons, while the total imported into the Colony from Yunnan for six months was estimated to be around 6,000 tons. America and Europe took about 6,500 tons, of which the major part went to the United States. Other shipments, including China coast ports and Japan, amounted to 850 tons.

Average prices of cash standard tin: January 1919, £248. 9s. 10d.; December 1918, £267. 14s. 3d.; January 1918, £293. 6s. 1d.; December 1917, £298. 10s.

Our imports for December were 797 tons against 1,519 tons in 1917, making the total for the year 12,567 tons compared with 27,143 tons in 1917.

SPELTER.—According to the published figures the Government stocks in this country on January 1 stood at 22,273 tons of G.O.B. spelter, while those of refined amounted to 8,017 tons. These figures show increases of 3,505 and 1,473 tons respectively. Business in the article has not been particularly brisk during the period under review. Naturally so long as consumers see a sufficiency of metal in sight there is little to induce them to rush into the market, especially with prices at their present level. Of course if they had good business to cover, the situation would be altered, but at present the demand for the ultimate product of the galvanizers is anything but satisfactory. Meanwhile values here have been fairly well maintained, while other markets such as that of America have shown an easier tendency. The demand there appears also very slow to develop, although hopes have been expressed from time to time that a revival was about to be seen. This has apparently not matured, and prices of spot metal in the States have steadily declined to well under 7c. per lb. It is now reported that steps are contemplated for an immediate reduction in the output of the metal, and this may eventually help the situation. For higher-grade metal it is understood that Japan is a seller, but at the present moment business seems

DAILY LONDON METAL PRICES: OFFICIAL CLOSING PRICES ON Copper, Lead, Zinc and Tin per Long Tons; Silver

	Silver	Copper					Lead
		Standard Cash	Standard (3 mos.)	Electrolytic	Best Selected		Soft Foreign
Jan.	d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.		£ s. d. £ s. d.
[illegible]	[illegible]	93 [illegible] 0 to 94 0 0	[illegible] to 84 10 [illegible]	105 0 [illegible] to [illegible]	103 0 0 to 101 0 0		10 0 0 to 32 10 0
13	[illegible]	[illegible] 0 [illegible] to 95 [illegible] 0	[illegible] 10 [illegible] to 84 0 [illegible]	[illegible] 0 0 to 103 0 0	10[illegible] 0 0 to 101 0 0		40 0 0 to 32 10 0
14	[illegible]	93 [illegible] 0 to 94 0 0	[illegible] 0 [illegible] to [illegible] 0 0	105 [illegible] to [illegible]	103 0 0 to 101 0 [illegible]		40 0 0 to 32 10 0
[illegible]	[illegible]	[illegible] 0 0 to 92 0 0	[illegible] to [illegible] 0 0	105 [illegible] to 103 0 0	[illegible] 0 [illegible] to [illegible] 0 0		40 0 0 to 32 10 0
16	[illegible]	[illegible] 0 0 to 91 0 [illegible]	80 0 [illegible] to 81 [illegible] 0	105 0 [illegible] to 103 0 0	103 0 0 to 101 0 0		40 0 0 to 32 10 0
17	[illegible]	92 0 0 to 93 0 0	[illegible] 0 [illegible] to [illegible] 0 0	105 [illegible] 0 to [illegible] 0 0	[illegible] 0 0 to 101 0 0		35 0 0 to 30 0 0
[illegible]	48[illegible]	93 0 0 to 94 0 0	83 0 0 to 84 [illegible]	[illegible] 0 0 to [illegible] 0 [illegible]	103 0 0 to 101 0 [illegible]		35 0 0 to 30 0 0
[illegible]	[illegible]	91 0 0 to [illegible] 0 0	84 [illegible] to [illegible] 0 0	105 [illegible] 0 to 103 [illegible] 0	[illegible]03 0 0 to 101 0 [illegible]		35 0 0 to 30 0 0
22	[illegible]	91 0 0 to [illegible] 0 0	84 10 0 to [illegible]	[illegible] 0 [illegible] to 103 0 0	103 0 [illegible] to [illegible] 0 [illegible]		35 0 0 to 30 0 0
[illegible]	[illegible]	90 0 0 to [illegible] 0 0	[illegible] 0 [illegible]	105 0 0 to 103 0 0	103 [illegible] 0 to 101 0 0		35 0 0 to 30 0 0
[illegible]	[illegible]	89 0 0 to 90 0 0	[illegible] 0 [illegible] to 83 [illegible] 0	[illegible] 0 to [illegible] 0 [illegible]	[illegible] 0 [illegible]		35 0 0 to 30 0 0
27	[illegible]	[illegible] 0 0 to 90 0 0	[illegible] 0 [illegible] to 84 [illegible] 0	105 0 [illegible] to 103 0 0	[illegible] to [illegible]1 0 0		35 0 0 to 30 0 0
[illegible]	[illegible]	[illegible] 0 [illegible] to [illegible]	83 0 [illegible] to [illegible]	[illegible] to [illegible] 0 0	10[illegible] 0 0 to 101 0 0		35 0 0 to 30 0 0
[illegible]	48[illegible]	[illegible] 0 0 to [illegible] 0 0	81 [illegible] to [illegible] 10 [illegible]	105 [illegible] 0 to [illegible] 0	1[illegible] 0 0 to 101 0 0		34 0 0 to 29 10 0
30	[illegible]	87 [illegible] 0 to 88 [illegible] 0	80 [illegible] to [illegible] 1[illegible]	[illegible] 0 0 to 1[illegible]	103 0 0 to 101 0 0		32 0 0 to 29 10 0
[illegible]	[illegible]	[illegible] 0 0 to [illegible]	79 1[illegible] 0 to 80 0 0	105 0 [illegible] to 103 0 0	103 0 0 to 101 0 0		32 0 0 to 29 10 0
Feb.							
[illegible]	[illegible]	87 0 0 to 88 0 0	80 0 0 to [illegible] 10 0	[illegible] 0 0 to 103 0 [illegible]	103 0 0 to 101 0 0		30 0 0 to 28 0 0
4	[illegible]	87 0 0 to 88 0 [illegible]	80 6 0 to 80 0 0	105 0 [illegible] to 103 0 0	103 0 0 to 101 0 0		30 0 0 to 28 10 0
5	[illegible]	[illegible] 0 0 to 87 [illegible]	[illegible] 0 [illegible] to [illegible] 0 0	105 0 [illegible] to [illegible] 0 [illegible]	103 0 0 to 101 0 0		29 10 0 to 27 0 0
[illegible]	[illegible]	83 0 0 to 85 [illegible]	[illegible] to [illegible] 0 [illegible]	[illegible] 0 0 to [illegible] 0	103 0 0 to 101 0 [illegible]		29 10 0 to 26 0 0
[illegible]	[illegible]	[illegible] 0 to [illegible]	74 10 [illegible] to 75 10 0	100 0 [illegible] to [illegible] 0 [illegible]	[illegible] 0 0 to 90 0 0		29 10 0 to 26 0 0
[illegible]	[illegible]	[illegible] 0 0 to 81 0 0	70 0 0 to [illegible] 0 0	[illegible] 0 0 to 90 0 [illegible]	[illegible]5 0 [illegible] to 90 0 0		29 0 0 to 25 0 0
11	47[illegible]	79 0 0 to [illegible] 0 0	70 10 0 to 71 10 0	100 0 0 to 90 0 0	95 0 0 to 90 0 0		29 0 0 to 25 0 0

hardly probable, although with easing freights it may become practicable. It has already been reported, however, that some fair quantities bought by this country from the States have not yet been able to be shipped.

Average prices for good ordinary brands: January 1919, £[illegible] 15s. 11d.; December 1918, £54; January 1918, £52; December 1917, £52.

Our December imports of spelter were 5,823 tons compared with 8,054 in 1917, making the total for the year 64,138 tons compared with 76,105 tons in 1917.

ZINC DUST.—Australian [illegible] quoted at £88 per ton; English 70 to 75% at £75 per ton at works.

LEAD.—The stocks of this metal in this country held by the Government, which are exclusive of old metals and scrap, amounted on January 1 to 62,852 tons, this displaying an increase over the previous month of 13,741 tons. As will be noticed this increase is very important, and in fact the stocks in this country can only be considered exceedingly high compared with pre-war times. The tendency of the market, as was to be expected, has been downward. The first signs of an easing of conditions were about the middle of the month, when the Government reduced the selling price by £5 to £35 per ton. Since then, however, metal has been sold at lower figures in the open market on the Metal Exchange, with the result that prices were marked down further. Meanwhile America has also been easier, and not only have bids been solicited from this side, but metal has actually been sold and apparently already arrived here. The trade in this country with consumers has been very much restricted, this being mainly due to lack of orders from the building trade, which has not yet got properly started. A good inquiry was seen at one time for export to neutrals bordering upon enemy countries. Apparently, however, the business was not considered desirable by our authorities, as, so far as is known, none was exported. In a manner it seems unfortunate, as it would have materially reduced the large stocks, and stabilized the position. As it is, however, the business has apparently gone to America, which country is understood to have sold to both Holland and Denmark.

Our December imports of lead were 14,851 tons against 13,515 tons in 1917, making for 1918 a total of 208,932 tons compared with 147,124 tons.

Average net prices for soft foreign lead: January 1919, £34. 10s.; December 1918, £40; January 1918, £29; December 1917, £30 gross.

ANTIMONY.—Beyond the general downward tendency in values this market has been idle and uninteresting. The official price of English regulus was reduced to £55, but at this level little business appeared to transpire. In any case, foreign material in warehouse could be had at considerably less, the value of this being round about £50, though a little more or less was asked according to the quantity required. At the end of January, however, the Government made a further reduction in the price of English to £45, and it now remains to be seen whether this sharp cut will stimulate business, which has up to the present been very quiet. Foreign material will now have to be adjusted accordingly if business is to be expected. So far as crude is concerned, under present conditions costs of importing make business practically impossible, and values can only be called nominal. The Government stocks of antimony regulus showed an increase as at January 1 of 205 tons over the figures of the previous month, the total being 3,508 tons.

ARSENIC (White).—This market continues weak, and prices have fallen steadily. Latest figures are about £70 delivered.

BISMUTH.—12s. 6d. nominal per lb.

CADMIUM.—Weaker at 8s. to 8s. 3d. per lb.

ALUMINIUM.—Flat; £150 to home trade, £200 for export.

NICKEL.—Continues at £195 for the home trade.

PLATINUM.—New 440s., old 360s. per oz.

PALLADIUM.—500s. per oz. nominal.

QUICKSILVER.—Export prices are about £21 to £[illegible]

SELENIUM.—Weak at 12s. 6d. upwards.

TELLURIUM.—90s. to 105s. per oz.

SULPHATE OF COPPER is no better than £50, the fall in copper having flattened the price.

MANGANESE ORE.—Indian ores about 3s. per unit c.i.f. U.K.

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter)	Standard Tin Cash	Standard Tin 3 mos.
£ s d £ s. d.	£ s. d £ s d.	£ s. d. £ s. d.
56 0 0 to 45 0 0	252 0 0 to 252 10 0	243 10 0 to 244 0 0
56 0 0 to 45 0 0	254 10 0 to 255 0 0	246 10 0 to 247 0 0
56 0 0 to 45 0 0	253 0 0 to 254 0 0	246 0 0 to 247 0 0
56 0 0 to 45 0 0	251 10 0 to 252 0 0	246 0 0 to 246 10 0
56 0 0 to 45 0 0	250 0 0 to 250 10 0	245 10 0 to 245 0 0
56 0 0 to 45 0 0	249 10 0 to 250 10 0	245 0 0 to 245 10 0
56 0 0 to 45 0 0	250 10 0 to 251 0 0	246 10 0 to 247 0 0
56 0 0 to 45 0 0	249 10 0 to 250 0 0	245 5 0 to 245 10 0
56 0 0 to 45 0 0	247 0 0 to 247 10 0	244 0 0 to 244 5 0
56 0 0 to 45 0 0	247 10 0 to 248 0 0	243 15 0 to 244 0 0
56 0 0 to 45 0 0	247 15 0 to 248 5 0	245 0 0 to 245 10 0
56 0 0 to 45 0 0	247 15 0 to 248 5 0	244 10 0 to 244 15 0
56 0 0 to 45 0 0	245 15 0 to 246 5 0	242 5 0 to 242 10 0
56 0 0 to 45 0 0	244 10 0 to 245 0 0	241 10 0 to 241 15 0
56 0 0 to 45 0 0	245 0 0 to 245 15 0	242 5 0 to 242 10 0
56 0 0 to 45 0 0	245 5 0 to 245 10 0	242 5 0 to 242 10 0
49 0 0 to 41 10 0	245 10 0 to 246 0 0	242 10 0 to 243 0 0
49 0 0 to 41 10 0	245 15 0 to 246 0 0	243 0 0 to 243 10 0
48 0 0 to 40 0 0	244 15 0 to 245 5 0	242 0 0 to 242 10 0
48 0 0 to 40 0 0	239 0 0 to 240 0 0	236 10 0 to 237 0 0
48 0 0 to 40 0 0	233 0 0 to 234 0 0	233 0 0 to 234 0 0
48 0 0 to 40 0 0	224 10 0 to 225 10 0	223 0 0 to 224 0 0
48 0 0 to 40 0 0	226 0 0 to 226 10 0	223 15 0 to 224 5 0

WOLFRAM ORE.—The huge stocks and absence of demand have caused a collapse and the Government selling price of ores has been reduced to 40s. per unit 65% WO_3, though the Government buying price of Empire material is maintained at the old figure of 52s. 6d. in Australia, etc. America has been reported to be offering resale material, and Spain and Portugal are trying to find buyers. As elsewhere, control has plunged the trade into chaos.

MOLYBDENITE remains officially 105s. per unit for 85% MoS_2 for Empire material.

SILVER.—The price here is reduced to 47¾d. per oz. for bars, with the American quotation at 101⅛c.

COBALT METAL. 12s. 6d. to 13s. per lb

COBALT OXIDE.—7s. 9d. per lb.

CORUNDUM.—20% is quite nominal.

GRAPHITE.—80% £55 per ton c.i.f.

IRON AND STEEL.—The pig iron market has been very active during the period under review. A good inquiry has been seen for export to neutral countries, which, however, it has been impossible to satisfy owing to the withholding of licences. In any case it would appear that very little metal would be available for export, as home requirements seem quite able to absorb most of the supply. This is distributed as equitably as possible among the various users, but truck difficulties have to a certain extent hampered transport. Furnaces have not been working too well, and there has been rather a scarcity of foundry iron. In regard to steel, the position has not been too satisfactory on account of the complications arising out of the subsidy arrangements ; works, however, have been for the most part very well occupied with home business, export orders being difficult to handle owing to the difficulties of the conditions imposed in regard to the return to the Government of the subsidies, where export business is concerned. Some good orders, however, have been seen for railway material, &c. A new Exchange is being started in February, devoted to the interests, mainly, of the iron and steel trades. Hitherto these industries have not had any recognized meeting place in London, and accommodation is being provided at the Cannon Street Hotel on certain days where those interested may foregather.

PRICES OF CHEMICALS. February 10

		£	s.	d
Alum	per ton	19	0	0
Alumina, Sulphate of	,,	20	0	0
Ammonia, Anhydrous	per lb.		1	10
,, 0·880 solution	per ton	34	0	0
,, Carbonate	per lb.			6
,, Chloride of, grey	per ton	50	0	0
,, ,, ,, pure	per cwt.	4	0	0
,, Nitrate of	per ton	80	0	0
,, Phosphate of	,,	125	0	0
,, Sulphate of	,,	17	10	0
Antimony Sulphide	per lb.		1	3
Arsenic, White	per ton	70	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	46	0	0
Bleaching Powder, 35% Cl.	,,	15	0	0
Borax	,,	42	0	0
Copper, Sulphate of	,,	55	0	0
Cyanide of Sodium, 100%	per lb			10
Hydrofluoric Acid	,,			7
Iodine	,,		14	0
Iron, Sulphate of	per ton	8	0	0
Lead, Acetate of, white	,,	150	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	54	0	0
,, White	,,	60	0	0
Lime, Acetate, brown	,,	30	0	0
,, ,, grey 80%	,,	37	10	0
Magnesite, Calcined	,,	35	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate	,,	12	0	0
Methylated Spirit 64° Industrial	per gal.		8	7
Phosphoric Acid	per lb.		1	8
Phosphorus, yellow	,,		1	10
Potassium Bichromate	,,		2	3
,, Carbonate	per ton	110	0	0
,, Chlorate	per lb.		2	0
,, Chloride 80%	per ton	60	0	0
,, Hydrate, (Caustic) 90%	,,	400	0	0
,, Nitrate	,,	66	0	0
,, Permanganate	per lb		10	0
,, Prussiate, Yellow	,,		2	4
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	110	0	0
,, Arsenate 45%	,,	60	0	0
,, Bicarbonate	,,	8	10	0
,, Bichromate	per lb.		1	2
,, Carbonate (Soda Ash)	per ton	10	0	0
,, ,, (Crystals)	,,	4	5	0
,, Chlorate	per lb.		1	0
,, Hydrate, 76%	per ton	24	10	0
,, Hyposulphite	,,	21	0	0
,, Nitrate, 95%	,,	21	0	0
,, Phosphate	,,	47	0	0
,, Prussiate	per lb.		1	0
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)	,,	3	0	0
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	30	0	0
Sulphur, Roll	,,	22	0	0
,, Flowers	,,	28	10	0
Sulphuric Acid, Non-Arsenical... 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		3	5
Zinc Chloride	per ton	23	0	0
Zinc Sulphate	,,	23	0	0

STATISTICS.

Production of Gold in the Transvaal

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
Year 1916	8,971,359	324,179	9,295,538	39,484,934
Year 1917	8,714,866	307,527	[illegible]	[illegible]
January, 1918	694,121	19,991	[illegible]	3,033,653
February	637,571	22,188	659,759	2,802,477
March	677,008	19,273	696,281	2,957,614
April	697,733	19,366	717,099	3,046,045
May	720,539	20,778	741,317	3,148,915
June	708,908	18,788	727,696	3,091,058
July	716,010	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	640,797	17,904	658,701	2,797,983
December	630,505	10,740	641,245	2,723,836
Year 1918	8,197,959	221,734	8,419,693	35,766,688

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1918	176,424	11,469	4,715	192,608
February 28	181,066	11,243	4,825	197,134
March 31	183,055	11,076	4,745	198,876
April 30	182,462	11,322	4,783	198,567
May 31	179,879	11,211	4,773	195,863
June 30	179,028	11,473	4,747	195,248
July 31	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September 30	179,399	12,108	4,889	196,395
October 31	173,153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637

Cost and Profit on the Rand

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
October, 1917	2,280,461	26 10	19 5	7 2	814,211
November	2,156,814	27 4	19 11	7 2	775,502
December	2,130,510	27 7	20 0	7 4	783,729
January, 1918	2,167,411	27 1	20 7	6 4	703,665
February	1,946,338	27 8	21 7	5 11	577,396
March	2,107,561	27 1	21 4	5 8	596,109
April	[illegible]	27 0	20 8	6 2	670,871
May	2,237,644	27 3	20 6	6 5	716,963
June	2,124,205	28 2	21 0	6 11	736,694
July	2,167,869	27 10	21 2	6 6	702,360
August	2,158,431	28 1	21 7	6 3	676,146
September	2,060,635	28 2	22 0	5 10	600,330
October	2,015,144	28 0	22 5	5 3	531,774
November	1,899,925	28 5	23 1	5 1	480,102

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1917	1918	1917	1918
	£	£	£	£
January	296,113	253,807	131,665	107,863
February	289,734	232,023	104,892	112,865
March	300,183	230,023	158,727	112,605
April	297,977	239,916	123,825	117,520
May	299,271	239,205	121,104	126,290
June	302,195	[illegible]	114,489	120,273
July	288,731	251,740	142,017	117,581
August	294,359	257,096	130,278	120,526
September	[illegible]	247,885	127,168	115,152
October	289,978	136,780	126,295	[illegible]
November	275,829	145,460	[illegible]	108,796
December	270,616	192,870	122,602	112,621
Total	3,495,391	2,652,250	1,529,977	1,333,553

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January, 1918	*	73,703	*	*
February	*	76,987	*	*
March	*	69,730	*	*
April	*	66,079	*	*
May	*	73,701	*	*
June	*	74,904	*	*
July	*	72,081	*	*
August	*	76,156	*	*
September	*	74,057	*	*
October	*	71,439	*	*
November	1,444	70,711	72,155	305,494
December	2,739	61,314	64,053	272,208
January, 1919	*	69,954	*	*

* By direction of the Federal Government the export figures from July, 1916, to November, 1918, were not published.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1917	1918	1917	1918	1917	1918
	£	£	£	£	£	£
January	67,627	32,134	50,150	47,600	29,000	25,000
February	65,450	58,113	63,200	45,470	26,000	28,000
March	74,794	65,412	61,200	48,020	41,000	30,000
April	75,139	26,849	62,470	47,600	21,000	30,000
May	65,623	87,885	65,450	46,740	28,400	45,000
June	64,180	45,765	73,100	51,420	24,600	32,000
July	68,937	64,347	71,820	51,000	44,000	25,000
August	101,428	61,163	74,800	44,600	21,000	21,000
September	61,701	65,751	64,180	45,900	20,000	32,000
October	33,533	—	54,400	54,400	47,000	40,000
November	75,912	—	42,380	38,200	29,000	25,000
December	56,967	—	64,170	52,800	19,000	38,000
Total	846,540	508,853	744,537	553,750	349,000	370,000

Production of Gold in India.

	1915	1916	1917	1918
	£	£	£	£
January	201,255	192,150	190,047	176,030
February	195,970	183,264	180,904	173,343
March	194,350	186,475	189,618	177,950
April	196,747	192,208	185,835	176,486
May	199,786	193,604	184,874	173,775
June	197,447	192,469	182,426	174,375
July	197,056	191,404	179,660	171,950
August	197,984	192,784	181,005	172,105
September	195,952	192,330	183,630	170,360
October	195,531	191,502	182,924	167,740
November	192,714	192,298	182,388	157,176
December	204,590	205,164	190,852	170,630
Total	2,369,382	2,305,652	2,214,163	2,061,920

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1918	Jan 1919
	Tons	Tons
Iron Ore	6,565,860	555,264
Copper Ore	15,319	3,789
„ Precipitate	21,031	1,954
„ Metal	203,943	14,591
Copper and Iron Pyrite	836,703	33,942
Tin Concentrate	32,329	5,754
„ Metal	12,567	825
Manganese Ore	365,606	33,216
Lead, Pig and Sheet	208,932	25,153
Zinc (spelter)	64,138	11,187
Zinc Oxide	3,989	226
Baryte	1,480	270
Rock Phosphate	464,747	70,587
Brimstone	72,720	5,010
Boracic Compounds	9,282	2,185
Nitrate of Potash	19,184	758
	lb.	lb.
Quicksilver	1,077,460	—

Exports of Copper from United States

1917	Long tons	1918	Long tons	1918	Long tons
July	38,127	January	40,530	July	28,526
August	45,304	February	28,160	August	20,440
September	30,493	March	22,550	September	32,730
October	39,115	April	22,227	October	15,218
November	38,638	May	28,889	November	—
December	35,000	June	31,791	December	—
Total 1917	484,120	Total	182,786	Total 1918	279,998

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Nov. 1918 Tons	Dec. 1918 Tons	Year 1918 Tons
Nigeria:			
Abu	2	–	33
Anglo-Continental	12	16	207
Benue	6	7	146
Bisichi	19	20	275
Bongwelli		–	15
Dua	4	9	60
Ex-Lands	–	26	320
Filani	3	2	37
Forum River	15	15	274
Gold Coast Consolidated	–	–	30
Gurum River	6	12	99
Jantar	–	12	132
Jos	17	–	210
Kaduna	27	22	172
Kano	10	12	60
Kassa-Ropp	10	10	133
Keffi	4	6	118
Kuru	–	12	12
Kuskie	1	1	21
Kwall	5	4	108
Lower Bisichi	9	8	99
Lucky Chance	2	2	27
Minna	1	–	40
Mongu	31	35	476
Naraguta	34	31	478
Naraguta Extended	23	27	280
New Lafon	20	20	198
Nigerian Tin	8	8	87
N. N. Bauchi	25	20	435
Offin River	7	11	119
Rayfield	44	55	689
Ropp	68	–	771
Rukuba	8	9	132
South Bukeru	2	3	94
Sybu	2	2	40
Tin Areas	8	7	96
Tin Fields	4	7	108
Toro	1	–	15
Federated Malay States:			
Chenderiang	–	45	179
Gopeng	87	86	979
Idris Hydraulic	12	14	136
Ipoh	13	16	245
Kamunting	–	71	236
Kinta	36	42	478
Kledang	–	10	28
Lahat	24	18	399
Malayan Tin	59	50	730
Pahang	152	153	1,877
Rambutan	21	16	207
Sungei Besi	42	42	408
Tekka	30	47	508
Tekka-Taiping	33	30	400
Tronoh	131	132	1,364
Tronoh South	5	2	133
Cornwall:			
Cornwall Tailings	–	–	140
Dolcoath	56	62	787
East Pool	142	142	1,336
Geevor	29	–	369
South Crofty	40	58	598
Other Countries:			
Aramayo Francke (Bolivia)	176	185	1,816
Briseis (Tasmania)	25	20	327
Deebook (Siam)	30	30	398
Mawchi (Burma)	54	50	658
Porco (Bolivia)	26	21	227
Renong (Siam)	44	50	615
Rooiberg Minerals (Transvaal)	25	30	335
Siamese Tin (Siam)	56	71	959
Tongkah Harbour (Siam)	88	87	1,528
Zaaiplaats (Transvaal)	42	45	533

Nigerian Tin Production

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1913 Tons	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons
January	466	485	417	531	667	678
February	427	469	358	528	646	668
March	510	502	418	547	655	707
April	430	482	444	486	555	534
May	360	480	357	536	509	525
June	321	460	373	510	473	492
July	357	432	455	506	479	545
August	406	228	438	498	551	571
September	422	289	442	535	535	514
October	480	272	511	584	578	491
November	445	283	467	679	621	440
December	478	326	533	654	655	433
Total	5,103	4,708	5,213	6,594	6,927	6,648

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Total, 1917	4,186	£561,003	£134 0 0
January 14, 1918	141	£23,563	£167 2 3
January 28	171½	£28,976	£168 19 2
February 11	166½	£29,674	£178 4 6
February 25	156½	£28,213	£180 18
March 11	178¼	£33,398	£187 7 4
March 25	169½	£31,253	£184 7 9
April 8	157¼	£29,575	£188 1 8
April 22	159½	£31,402	£196 17 7
May 6	172½	£39,999	£232 4 4
May 21	169½	£36,791	£217 1 2
June 3	172	£36,109	£209 18 9
June 18	153	£29,693	£194 1 9
July 1	170½	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¾	£33,816	£230 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£28,793	£202 1 2
September 24	145¾	£29,639	£203 7 2
October 7	136½	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	166¾	£25,170	£150 19 0
December 16	175½	£26,032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786,541	£192 0 0
January 13, 1919	160	£20,888	£130 11 0
January 27	135½	£17,009	£125 10 7

Details of Redruth Tin Ticketings.

	Tons Sold January 13.		Tons Sold January 27.	
	Tons Sold	Realized per ton £ s. d	Tons Sold	Realized per ton £ s. d.
E. Pool & Agar, No. 1	15	132 10 0	15	128 0 0
„ „ No. 1a	15	130 0 0	15	128 0 0
„ „ No. 1b	15	129 0 0	15	126 10 0
„ „ No. 1c	15	127 10 0	—	—
Dolcoath, No. 1	8	133 5 0	9	133 10 0
„ No. 1a	8	132 10 0	9	131 7 6
„ No. 1b	8	134 0 0	9	[illegible]
„ No. 2	[illegible]	75 0 0	[illegible]	60 0 0
„	1½	110 0 0	1½	[illegible]
South Crofty, No. 1	10	131 10 0	10	128 10 0
„ „ No. 1a	10	130 0 0	10	128 0 0
Grenville Utd., No. 1	7	132 0 0	7	126 10 0
„ „ No. 1a	7	132 0 0	6	[illegible]
„ „ No. 2	—	—	3½	[illegible]
Tincroft Mines, No. 1	7	137 12 6	7	[illegible]
„ „ No. 1a	7	[illegible]	7	[illegible]
Levant Mines	—	—	—	
Basset Mines	8	130 0 0	7	[illegible]
Wheal Bellan		—	2	[illegible]
Porthledden	1	127 0 0	—	
Total	160		135½	

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Feb. 5, 1918 £ s. d.	Feb. 7, 1919 £ s. d.
RAND		
Bantjes	3 3	[illegible]
Brakpan	5 5 0	3 17 6
Central Mining (£8)	6 3 9	7 15 0
Cinderella	4 6	6 0
City & Suburban (£4)	1 3 9	12 6
City Deep	3 5 6	2 17 0
Consolidated Gold Fields	1 14 6	1 15 0
Consolidated Langlaagte	17 6	19 6
Consolidated Main Reef	15 0	14 6
Consolidated Mines Selection (10s)	1 8 3	1 8 0
Crown Mines (10s.)	2 0 0	2 8 9
Daggafontein	1 12 0	1 10 9
D. Roodepoort Deep	10 6	8 9
East Rand Proprietary	6 3	6 9
Ferreira Deep	16 0	15 9
Geduld	2 1 3	2 15 9
Geldenhuis Deep	15 6	13 9
Gov't Gold Mining Areas	3 15 6	4 19 6
Heriot	1 10 0	1 0 0
Jupiter	6 0	4 3
Kleinfontein	1 1 3	14 6
Knight Central	4 3	5 6
Knight's Deep	11 3	8 6
Langlaagte Estate	14 9	1 1 3
Meyer & Charlton	5 11 3	5 0 0
Modderfontein (£4)	25 5 9	28 0 0
Modderfontein B	8 13 0	8 1 3
Modder Deep	7 10 0	7 16 3
Nourse	1 0 0	16 3
Rand Mines (5s.)	2 18 9	3 1 3
Rand Selection Corporation	4 10 0	4 15 0
Randfontein Central	12 6	14 3
Robinson (£5)	1 0 0	16 0
Robinson Deep A (1s.)	1 5 0	1 0 0
Rose Deep	1 2 6	18 9
Simmer & Jack	5 3	4 6
Simmer Deep	3 6	2 9
Springs	3 13 9	3 11 3
Sub Nigel	1 10 0	1 10 6
Van Ryn	1 3	17 0
Van Ryn Deep	3 13 9	3 12 6
Village Deep	1 1 3	18 0
Village Main Reef	14 9	14 6
Witwatersrand (Knight's)	1 16 3	1 2 6
Witwatersrand Deep	9 6	12 6
Wolhuter	6 6	5 0
OTHER TRANSVAAL GOLD MINES		
Glynn's Lydenburg	1 0 0	1 5 9
Sheba (5s.)	1 3	1 6
Transvaal Gold Mining Estates	18 3	15 0
DIAMONDS IN SOUTH AFRICA		
De Beers Deferred (£2 10s.)	12 17 6	18 2 6
Jagersfontein	4 5 0	4 12 6
Premier Deferred (2s. 6d.)	7 7 6	7 0 0
RHODESIA		
Cam & Motor	13 3	8 3
Chartered British South Africa	16 0	1 3 0
Eldorado	9 0	6 0
Falcon	1 7 9	18 6
Gaika	1 6 3	16 0
Giant	9 6	8 0
Globe & Phoenix (5s.)	1 11 3	1 6 0
Lonely Reef	1 17 0	1 19 0
Rezende	4 5 0	4 10 0
Shamva	1 15 0	1 15 0
Wanderer (3s.)	1 9	1 0
Willoughby's (10s.)	6 0	7 0
WEST AFRICA		
Abbontiakoon (10s.)	5 0	5 6
Abosso	8 0	6 6
Ashanti (4s.)	18 6	1 2 0
Prestea Block A	6 0	5 6
Taquah	17 0	14 6
WEST AUSTRALIA		
Associated Gold Mines	4 0	3 3
Associated Northern Blocks	1 0	4 6
Bullfinch	1 [illegible]	
Golden Horse-Shoe (£5)	1 13 9	1 3 0
Great Boulder Proprietary (2s.)	11 3	12 0
Great Fingall (10s.)	1 0	2 0
Ivanhoe (£5)	2 0 0	1 13 0
Kalgurli	8 6	11 6
Sons of Gwalia	13 9	8 9

GOLD, SILVER, *cont.*	Feb. 5, 1918 £ s. d.	Feb. 7, 1919 £ s. d.
OTHERS IN AUSTRALASIA		
Mount Boppy, New South Wales	6 0	3 9
Talisman, New Zealand	15 0	12 0
Waihi, New Zealand	1 18 3	2 2 6
Waihi Grand Junction, New Z'lnd	17 9	14 3
AMERICA		
Alaska Treadwell (£5), Alaska	—	1 15 0
Buena Tierra, Mexico	12 0	1 1 3
Camp Bird, Colorado	7 9	17 9
Casey Cobalt, Ontario	6 6	3 6
El Oro, Mexico	9 3	17 0
Esperanza, Mexico	9 0	15 6
Frontino & Bolivia, Colombia	12 9	12 0
Le Roi No. 2 (£5), British Columbia	6 3	8 9
Mexico Mines of El Oro, Mexico	5 12 6	6 2 6
Oroville Dredging, California	18 9	1 0 6
Plymouth Consolidated, California	1 2 0	1 3 9
St. John del Rey, Brazil	18 0	17 6
Santa Gertrudis, Mexico	13 9	14 6
Tomboy, Colorado	19 6	14 6
RUSSIA		
Lena Goldfields	1 5 0	1 15 0
Orsk Priority	10 0	13 9
INDIA		
Balaghat	4 6	5 0
Champion Reef (2s. 6d.)	5 9	4 3
Mysore (10s.)	3 5 0	2 5 6
North Anantapur	5 0	3 0
Nundydroog (10s.)	1 6 0	1 1 3
Ooregum (10s.)	19 6	17 6
COPPER:		
Arizona Copper (5s.), Arizona	2 7 6	2 1 3
Cape Copper (£2), Cape Province	2 15 0	2 15 0
Chillagoe (10s.), Queensland	1 3	1 9
Cordoba (5s.), Spain	3 6	3 0
Great Cobar (£5), N.S.W	1 6	4 0
Hampden Cloncurry, Queensland	1 12 3	1 4 6
Kyshtim, Russia	1 3 0	1 15 0
Messina (5s.), Transvaal	8 0	5 0
Mount Elliott (£5), Queensland	4 0 0	3 10 0
Mount Lyell, Tasmania	1 7 0	1 4 6
Mount Morgan, Queensland	1 14 3	1 6 3
Namaqua (£2), Cape Province	2 10 0	2 2 6
Rio Tinto (£5), Spain	64 5 0	62 10 0
Sissert, Russia	1 0 0	1 1 6
Spassky, Russia	1 2 6	1 15 0
Tanalyk, Russia	1 3 0	2 1 3
Tanganyika, Congo and Rhodesia	3 12 6	4 1 3
Tharsis (£2), Spain	5 10 0	5 15 0
LEAD ZINC:		
BROKEN HILL		
Amalgamated Zinc	1 11 3	1 8 0
British Broken Hill	1 17 3	2 7 6
Broken Hill Proprietary (8s.)	2 17 0	3 4 0
Broken Hill Block 10 (£10)	1 8 3	1 12 0
Broken Hill North	3 0 0	2 18 0
Broken Hill South	10 15 0	2 17 6*
Sulphide Corporation (15s.)	1 7 0	1 6 0
Zinc Corporation (10s.)	1 1 0	1 7 3
ASIA		
Burma Corporation	4 6 3	5 10 0
Irtysh Corporation	1 4 6	1 15 0
Russian Mining	10 0	19 6
Russo Asiatic	2 17 6	4 0 0
TIN:		
Aramayo Francke, Bolivia	1 16 3	3 3 9
Bisichi, Nigeria	15 0	15 0
Briseis, Tasmania	5 9	5 0
Dolcoath, Cornwall	12 9	7 6
East Pool, Cornwall	1 4 6	1 5 0
Ex-Lands Nigeria (2s.), Nigeria	2 3	2 9
Geevor (10s.) Cornwall	18 0	19 6
Gopeng, Malay	1 16 3	2 1 3
Ipoh Dredging, Malay	15 6	1 0 0
Malayan Tin Dredging, Malay	2 3 9	2 7 6
Mongu (10s.), Nigeria	15 0	17 0
Naraguta, Nigeria	17 0	18 0
N. N. Bauchi Pref. (10s.), Nigeria	12 3	13 9
" Ord. (10s.)	6 0	8 6
Pahang Consolidated (5s.), Malay	11 0	14 6
Rayfield, Nigeria	11 9	14 6
Renong Dredging, Siam	2 7 6	2 2 6
Ropp (4s.), Nigeria	18 0	1 2 0
Siamese Tin, Siam	3 [illegible] 6	3 7 6
South Crofty (5s.), Cornwall	1 12 0	1 16 2
Tekka, Malay	3 15 0	4 2 6
Tekka-Taiping, Malay	3 15 0	3 17 6
Tronoh, Malay	1 12 0	1 17 6

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

IMPROVEMENTS IN ELECTROLYTIC EXTRACTION OF ZINC.

In the electrolytic method of extracting zinc from ore, one of the difficulties is caused by the presence of gelatinous silica in the solution. This is removed with other insoluble matter by filtering, but the cake holds so much solution which cannot be removed by washing that a large proportion of the dissolved zinc is lost. Frederick Laist, of Anaconda, has recently introduced improvements for the treatment of this cake and the recovery of the zinc. The *Engineering and Mining Journal* for December 28 contains an account of the improvements, the account being based on the specifications of United States patents 1,281,031-2. The journal states that further improvements have been made since the filing of these patents. The Anaconda company does not publish information relating to the technique of its electrolytic zinc process, so that any hints of procedure obtainable from the patent specifications may prove useful to metallurgists.

The article first discusses the usual procedure at the electrolytic zinc plant, the formation of gelatinous silica, and the trouble it causes. Concentrates containing, for example, about 33% zinc, 8% lead, 20% iron, and 6% insoluble matter, the last comprising about 4·5% silica and 1·5% alumina, are roasted in multiple-hearth furnaces to oxidize the sulphides into oxides and sulphates. The roasted product, or calcine, is then leached with a solution containing 8 to 9% of sulphuric acid, this solution, in a repetition of the process, being the depleted electrolyte from the cells in which the zinc is electrolytically precipitated. Usually, approximately five tons of leaching solution is used per ton of calcine. The resulting solution is then neutralized, or nearly neutralized, with calcine, and thereafter a small proportion of limestone is customarily added. The effect of this limestone addition is to establish a slightly alkaline condition in the liquor, and thereby to precipitate any silica which has been dissolved during the acid treatment. The silica is precipitated in gelatinous form. It is necessary to effect complete precipitation of the silica at this point, as it will otherwise separate during later operating stages and occasion much trouble. The precipitation may be rendered even more complete by adding to the pulp, after the limestone addition, a small amount of zinc dust. This reagent, either in the presence or the absence of copper salts, is effective for precipitating residual traces of dissolved silica. In the presence of copper salts the cement copper is, of course, the active reagent. The above-described operations of neutralizing the liquid and precipitating the silica are conveniently performed in Pachuca vats with thorough stirring. At this point the solution should carry at least 80% of the zinc content of the original calcine. The contents of the Pachuca vats are now discharged into Dorr thickeners, and the thickened product, with the precipitated matter, passes to the filters. The filtrate, together with the overflow from the Dorr thickeners, is a zinc solution usually containing small amounts of copper and cadmium. These metals are precipitated by zinc in dust or other suitable form, and the solution is clarified by settling or filtration and passed to the electrolytic cells. The entering electrolyte is a neutral solution containing about 8% of zinc in the form of sulphate; the depleted electrolyte flowing from the electrolytic cells contains about 2% of zinc as sulphate, with about 8 to 9% of sulphuric acid, and is returned to the leaching vats, as mentioned above. Lead anodes may be used, and the current conditions are preferably those which have become standard in this operation.

In the practice of the above-outlined process a filter cake is obtained which comprises the insoluble matter from the ore and the precipitated gelatinous silica. This is in the form of a wet cake, ordinarily containing 42 to 45% of moisture, which is, of course, a rich zinc-sulphate solution. It is impossible to wash the cake free from zinc with an amount of water within practicable limits, and the losses at this point may attain 15% of zinc content of the ore. Efforts have been made to reduce this loss by removing the leach liquor from the residue before neutralizing and while still containing about 0·5% of acid. The acid pulp was passed through thickeners and filters, and yielded a dry, sandy cake, containing only about 20% of moisture, and readily washed. However, the subsequent treatment of the acid solution with calcine, limestone, and zinc dust yielded an unworkable precipitate of gelatinous silica, this precipitate being slimy, slow-settling, and producing a cake containing up to 80% of moisture. The necessity of precipitating the gelatinous silica in presence of the sandy ore residue was therefore established.

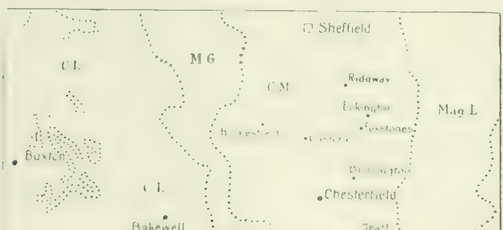
According to the new method, the mechanical difficulties due to the precipitation of gelatinous silica, as well as the excessive losses of zinc occasioned thereby, are avoided by proceeding as follows: The silica is precipitated in presence of the ore pulp, preferably by successive additions of calcine, limestone, and zinc dust, if required, the latter either with or without copper salts. The subsequent operations of thickening and filtration are easily carried out in apparatus of standard type, but yield, as above stated, a filter cake of high moisture content. This filter cake, which may be termed the "primary filter cake," and which need not be washed, is discharged from the press and dried or gently calcined at a temperature sufficiently high to effect dehydration of the silica, as well as the hydroxides of aluminium and iron, a temperature of about 150°C. being suitable. These compounds are thereby rendered insoluble in water or dilute acids, and are also converted into a granular condition which lends itself readily to filtration, the zinc remaining soluble. The dried residue is now leached with a sufficient quantity of acidified solution, so that, after the leaching is completed, a small excess of acid may remain. An 8% solution of sulphuric acid is suitable for this purpose. The pulp is now settled or thickened and washed. The washing is readily accomplished in the filter, and the residue, termed the "secondary filter-cake" is sandy or granular. The filtrate from the secondary filters, with the overflow from the secondary settling tanks, is acid, and is returned to the primary leaching vats, being introduced, preferably, just before the final neutralization with calcine or limestone.

In an alternative method, the solution from the filter, with the overflow from the Dorr thickeners, is a zinc solution usually containing small amounts of copper and cadmium. These metals are precipitated by zinc in dust or other suitable form, the solution clarified by settling or filtration and passed to the electrolytic cells. The entering electrolyte is a neutral solution containing about 8% of zinc in the form of sulphate. The depleted electrolyte flowing from the electrolytric cells contains about 2% of zinc as sulphate, together with about 8 to 9% of sulphuric acid, and is returned to the leaching vats as mentioned above. Lead anodes may be used, and the current conditions are preferably those which have now become standard in this operation. The filter cake contains the insoluble matter from the ore and the precipitated gelatinous silica. The preferred method for the recovery of the zinc consists of purification by treatment with zinc in dust or other suitable form, clarification by settling or filtration, or both, and electrolysis with insoluble anodes, as, for example, lead. It has been found practicable, even with this dilute solution, to recover economically 75% or upward of the zinc content by electrolytic precipitation. The spent electrolyte may afterward be either discarded or worked up by any appropriate method for its residual zinc content.

BORING FOR OIL IN DERBYSHIRE.

During the last year or two we have referred several times to the chances of finding petroleum in England, and have given particulars of Lord Cowdray's undertaking in connection with boring for oil in Derbyshire. Lord Cowdray's firm, S. Pearson & Son, Ltd., has not published much with regard to the project or the geological arguments on which it is based. A paper written by T. Sington and published by the *Iron & Coal Trades Review* for October and December 27 gives the information that has heretofore been lacking, though the writer is frankly sceptical as to the results. Mr. Sington also read a paper on the subject before the Manchester Geological & Mining Society in January. We give a brief précis of these two papers herewith, and we have added a locality map.

The area in which borings are being made is bounded on the east by the Magnesian Limestone escarpment, extending north and south in a broken undulating line, and on the west by the Pennine Chain, which consists of Carboniferous Limestone and rises to heights of 1,000 ft., and in places to over 1,000 ft. The North Derbyshire coalfield, lying between these totally different formations, is an undulating district, varying from about 200 to 600 ft. above sea-level. The underlying rocks only crop out on the surface very occasionally in road and railway cuttings and quarries as they are concealed below a thin covering of loamy soil forming part pasture and part productive arable land. The essential feature of the coalfield is the great anticlinal arch, about 15 miles in length, extending from Holmesfield to Unstone in an east and west direction, and from Unstone to Skegby from north-west to south-east. Many oilfields abroad with special unmistakable features suggesting oil below have an anticlinal rock structure; therefore it is urged that the North Derbyshire anticlinal may also contain oil, in spite of the fact that the usual geological and other characteristics of large oil-producing districts are wanting. The entire coalfield under which the searchers expect to find oil is dotted over with collieries, many of great size. The mines are mostly shallow compared with those of other coalfields, due no doubt to the anticlinal and the faults. The borers expect to find oil when they get below 2,000 ft. depth, that is, below the level of the deepest coal mine of the district.



MAP SHOWING BORINGS FOR OIL IN DERBYSHIRE.
References: C L = Carboniferous Limestone, M G = Millstone Grit, C M = Coal Measures, Mag L = Magnesian Limestone, Tr = Trias.

There are in all seven boring sites, on the east side of Chesterfield, extending in a north and south line, 19 miles in length. Of these, two are on, or close to, the crown of the anticlinal; one is on the west side, two south of it, one east, and another to the north-east. From north to south the sites are as follows: (1) Ridgeway, (2) Foxstones, (3) Brimington, (4) Heath, (5) Hardstoft, (6) South Normanton, (7) Golden Valley. Of these at the time of writing (end of November) No. 5 is working and is down about 500 ft.; it is being sunk at the rate of about 20 ft per day. No. 3 has the derrick about complete, and the other buildings about three-parts completed. No 2 has some plant on the ground; while the others have either little or no plant as yet. It is expected that, barring accidents, No. 5 bore will be down the intended depth (about 4,000 ft.) during May.

The two most northerly bore holes are within easy reach of Eckington, a small mining town about six miles south-east of Sheffield, and the same distance north-east of Chesterfield. The general level of the country is 500 ft. above sea level, with small areas over 600 ft and occasional valleys down to nearly 200 ft. It is dotted over with collieries. About four miles to the east the Middle Coal Measures, on which the town stands, pass under the Magnesian Limestone, and about a mile to the west the Lower Coal Measures come to the surface, so that both the bore holes miss the bulk of the coal seams; evidently nothing is expected from them around Eckington.

No. 2 site is about 250 ft. above sea-level. The site is about three miles east of Unstone, where the anticlinal turns from a west to east direction to one running north-west to south-east, and it has evidently been selected to bore through some of the coal seams which crop up and are worked beyond the arch. Some plant has already been placed on the ground, but otherwise work has not yet commenced. The bore-hole is on the Middle Coal Measures, and will pass through the Manor and Silkstone coal seams, missing all those above them; it will therefore explore nearly the same ground as the No 1 bore. There is a fault running east and west just north of No 2 bore, so that under no conditions could the two bore-holes near Eckington interfere with each other.

Site No. 1 is at Ridgeway, a village on high ground which slopes away west, south, and east, clear of the colliery district. It is about 2½ miles from Eckington, within five miles of the centre of Sheffield, and about three miles from the bend of the anticlinal at Unstone. Nothing so far has been done on the site.

No. 3 site, near the small town of Brimington, about two miles north-east of Chesterfield, is in a small area of Lower Coal Measures, about 4½ miles long and one broad, completely surrounded by Higher Coal Measures, obviously brought to the surface by the anticlinal, the crown of which is either directly under the site or just west of it. The bore will therefore pass through rocks very similar to those which will be explored by bore-hole No. 1. A number of important faults isolate this bore-hole from all the others. Boring was expected to commence before the end of 1918.

The site of No. 4 bore-hole, close to the village of Heath, is 4¾ miles south-east of No. 3 bore-hole, 2¾ miles due north of No. 5 site, and 4¾ miles south east of Chesterfield; it is directly on the summit of the anticlinal, and will pierce the coal seams passing over the arch. No start has yet been made with the work. The derrick, when erected, will be a prominent object, as the site is 500 ft. above sea-level, and the ground falls away more or less, more especially to the east, in which direction the dip of the rocks and the gradient of the road appear to coincide. To the east, the Magnesian Limestone escarpment, 1¾ miles distant, rises prominently over the Coal Measures, which visibly dip below it. The bore will be on the Middle Coal Measures, and is separated from the one farther south by a fault, which extends right across the coalfield.

The fifth bore-hole, at Hardstoft, is for the moment the most interesting, as it is the only one as yet working; boring was started October 15, and has been carried on continuously. The site is 2¾ miles due south of No. 4 bore hole, and four miles due north of No. 6. The derrick is a prominent landmark, and can be seen from miles around, as it is on ground over 600 ft. above sea-level, and the ground falls rapidly all round. The bore is about two miles west of the anticlinal. The Limestone escarpment is about 1¾ miles to the east, and about a mile to the north there is a fault, already mentioned, of 180 ft. throw, which cuts off the area round this bore from that round the one further north.

Four miles south of the Hardstoft bore-hole a site for the sixth has been selected among level fields a little south of the road extending from Alfreton to Mansfield. The ground is about 500 ft. above sea-level. Excavation of the water reservoir had just commenced, and the men's barracks were in course of erection when the writer recently visited the site. There are several collieries in the surrounding country; the site is on the Middle Coal Measures, about three miles west of the Magnesian Limestone, and it is not in any way affected by the anticlinal, which is five miles away. Immediately to the south there are several small faults, which isolate this bore-hole from the one farther south in the Golden Valley. It is important and interesting to note that this bore-hole is not very far north of the old Riddings mine where oil seepages have been found.

The No. 7 bore-hole, the last of the series, is in the Golden Valley, three miles due south of No. 6. It has evidently been selected to test the ground near the old Riddings coal mine. The site is about 375 ft. above sea-level, a mile or so due west of Codnor station, and about 3½ miles from Alfreton. A tangle of faults, extending from north-west to south-east, and others nearly north and south, occur in the vicinity; they completely isolate the area in which this bore-hole is to be sunk; in fact, one of the principal faults appears to be close to it. Nothing has yet been done on the site. The result obtained from this boring will be awaited with considerable interest, as it will decide the point whether the former output of mineral oil in the Riddings mine was a mere pocket, or an escape from a large store at a deeper level. It seems highly probable that the pocket of oil found within about a mile of the proposed bore-hole is in some way directly associated with the extensive faulting of the surrounding district; it may possibly have owed its existence to them. Several coal seams and a number of collieries occur in the neighbourhood; the coalfield at this point is about seven miles in width, and the bore-hole is very nearly in a central position. The anticlinal is in no way associated with this bore, as it is nearly eight miles distant.

Plant for ten bores has been brought to this country from America. Seven have been accounted for in this article; where the others will be located is not yet known. Before the end of 1919 all the seven will no doubt have reached their intended depth, and the results will have been made public.

If the Derbyshire borings do not give the expected results, the borers may turn to South Wales or to Scotland; or they may try the more recent formations east of a line extending from Dorset to the Wash on the west side of Norfolk.

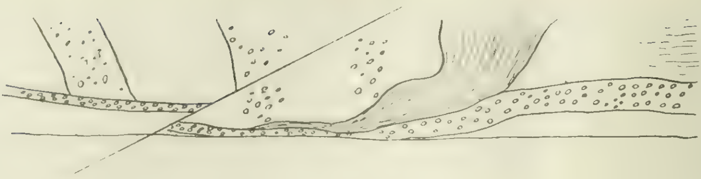


FIG. 1.

THE FOOT-WALL IN THE BRAKPAN MINE.

Those who are conversant with the geology of the Rand are aware that certain readily distinguishable bands or beds of rock can be and are used for the purpose of identifying the profitable gold-bearing layers of banket. The study of the stratigraphy of the Far East Rand is usually held to be simplified in this way by the existence of the "slate" foot-wall, correlatable with the "black bar" of the Central Rand. A paper by L. W. Macer founded on experience at the Brakpan and read at the November meeting of the Chemical, Metallurgical, & Mining Society of South Africa, goes to show that this slate foot-wall is of a variable nature, both petrologically and in its mode of occurrence, and that it is not so readily distinguished as is generally supposed. The observations are useful also as contributions to the discussion of the origin of Rand banket.

The variations of the black bar as existing on the Central and Far East Rand, namely, from a black satiny slate to a banded pyritic quartzite and coarse conglomerate, all exist in the Brakpan mine. The change from fine to coarser sedimentation, in most cases, takes place gradually, the shale becoming more quartzitic and finally containing pebbles. Occasionally the coarseness of the constituents increases rapidly and irregularly, and the reef is found lying upon a conglomerate with very little quartzitic matrix. This condition is shown in Fig. 1, which represents an exposure along the 15a W drive at Brakpan. Here the foot-wall changed from normal slate to quartzite, in which two steeply inclined beds of conglomerate were encountered. After passing the small reversed fault, reef was exposed in the roof of the drive, lying on a few inches of shale. This shale widened and passed into the foot, having the appearance of having been intruded from below. Farther west the foot-wall became more shaly, and finally changed into the normal foot-wall slate. In this instance the reef had a well defined foot-wall parting, but in many cases in this mine it is rather difficult to see where the pay reef ends and the foot wall bastard begins. Under these conditions, it is obvious that there is a possibility of error occurring in the interpretation of the data available from a bore-hole core or the intersection of reef in a shaft. This possibility led Mr. Macer to study the foot-wall bastard, and in this paper he places on record some of the distinguishing characteristics of the deposit.

In the foot-wall conglomerate the quartz pebbles have a more milky appearance than have those of the Main Reef Leader, although clear vein quartz pebbles also occur. There is a considerable variation in size and shape of the pebbles of the bastard reef. Black quartzite (chert) is not so frequently found, but pebbles of grey, fine quartzite are numerous. The main distinguishing feature is the occurrence of pieces of yellowish grey or greenish rock, which, after a few weeks' exposure to the mine air, turn brown. Under the microscope this rock consists of a micro-crystalline groundmass of quartz with a few opaque, eroded crystals, and is probably an altered quartz-porphyry. In the hand specimen these fragments of rock appear to have been originally softer than the other constituents of the conglomerate, and to have been squeezed into irregular shapes and indented by the quartz pebbles. This irregularity in shape of the fragments gives the weathered rock the general appearance, at a distance, of having been splashed with brown mud. The matrix is quartzitic, and pyrite is scarcely noticeable. The gold value is practically nothing.

Sedimentary matter with the appearance of having been intruded is mentioned by Geikie (in "Text-Book of Geology" p. 665) and other geologists, but does not appear to have been previously observed on the Far East Rand. The writer's attention was first drawn to these dykes by the difficulty which was being experienced in distinguishing between hand specimens of dyke and foot-wall. Thin sections of the so-called dyke matter had almost the same microscopic appearance as the normal black bar, and on examining the dykes *in situ*, they were found to be intrusions of foot-wall. It appears probable that the more argillaceous portions of the foot-wall beds have retained their plasticity long after the superincumbent quartzose beds were laid down and partly consolidated, and that as the latter became heavier the clayey deposits were forced up along lines of least resistance.

Fig. 3 shows a typical occurrence (main inclined shaft, Brakpan) which has been mistaken for an igneous dyke. The flow structure, as indicated in the figure, is very obvious.

The occurrence illustrated in Fig. 2 is interesting as an instance of the way in which these intrusions may lead to error in development. In this case the round broke to the line of the fault, showing a face of slate nearly to the roof of the drive. The indication was that an up-throw had been encountered. The next round showed the reef in the normal position. Had this intrusion been of greater extent it is probable that the rise would have been steepened to look for the reef, which would then have been passed over.

The intrusions do not extend a great distance laterally, as is shown in Fig. 4. In this case five cross-cuts were driven in faulted ground at varying intervals over a total distance of 500 ft. Three of these cross-cuts are illustrated, the ones at either end being omitted, as they only disclosed simple faults. At first sight it appears that these intrusions occur in fault planes, but after the examination of a number of cases the writer is of opinion that the intrusions occurred first, and by

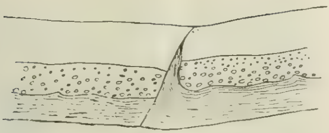


Fig. 2.

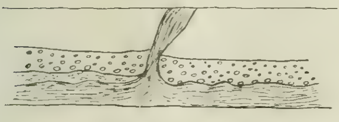


Fig. 3

Fig. 4

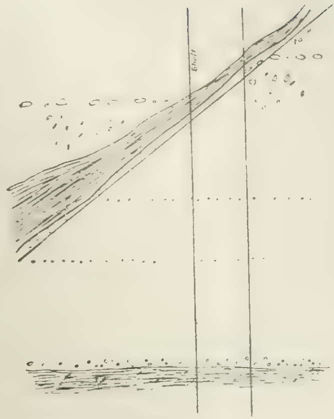


Fig. 5

forming lines of weakness they led to the formation of faults.

It is obvious that the intrusion of masses of sediment, indistinguishable petrologically from the normal foot-wall, may lead to futile excursions into the hanging wall by rising or cross-cutting, and that the geology of the black bar is therefore worthy of the attention of those engaged in development work. To those engaged in the exploitation of new areas it is of even more importance, as it is possible for a drill hole or even a shaft to intersect an area of irregular sedimentation, complicated with faulting, and to pass the Main Reef Leader unnoticed. Such a possibility is illustrated in Fig. 5

All of the difficulties here illustrated occur in the Brakpan, namely, an intrusion of foot-wall with a fault, the Main Reef Leader consisting of a single layer of pebbles, and a further leader lying on slate at a depth below the Main Reef Leader of about 160 ft. Although not occurring in the same section, these phenomena were encountered within a radius of 200 ft. It is conceivable that a shaft put down as shown in Fig. 5 might have resulted in development being commenced upon a wrong horizon

The evidence exposed in the workings at Brakpan bears upon the origin of this formation, and it presents the opportunity of theorizing upon the conditions prevailing when the foot-wall beds were deposited. Within a comparatively small area there is evidence of extensive mud flats alternating with sand banks and pebbly banks, and the evidence supports Dr. Mellor's estuarian theory.

MAGNESITE, ITS OCCURRENCE AND USES.

At the Swansea meeting of the Ceramic Society, T. Crook, of the Imperial Institute, read a paper entitled "Magnesite as Raw Material," giving an outline of the history of its application, its uses, and occurrences. As this is a mineral that has come to the fore recently, we quote Mr. Crook at length. Owing to the length of the paper, we are not able to give the whole of it in one issue of the Magazine.

History and Uses.—The utility of crystalline magnesia for refractory purposes is not a recent discovery. Advantage was taken of it in scientific laboratories long before its economic importance was realized in the smelting industry, and its use on a large scale in metallurgical practice during recent years must be attributed to a growing taste for technical efficiency in furnace operations, rather than to any new knowledge that has been acquired concerning its refractory properties. This growing taste has been fostered by the production of sinter and bricks of good quality at a comparatively cheap rate, largely owing to the enterprise of a German firm, which led the way in the exploitation of the Styrian and other deposits of Austria-Hungary.

It is said that when Spaeter & Co., of Cologne, started mining enterprise in the Veitsch district of Styria, about 1880, they went there for the purpose of mining spathic manganese ore. Spathic iron ore has long been mined in that district, but the quality has steadily deteriorated as compared with other Styrian mines, and its exploitation had ceased to yield much profit. It was during the development of their manganese property that the Cologne firm realized the possibilities of refractory-magnesia production from the large deposit at Veitsch.

The exploitation of the Veitsch and other magnesite deposits of Austria-Hungary, and the growth of the Veitscher Magnesit Aktiengesellschaft as a monopoly, is merely an instance of what can be done by a sound business organization in which full use is made of the scientific and technical worker. The German company did not discover either the refractory properties of magnesia or the right way to make good magnesia bricks. They did, however, diligently enough, set their staff to work to produce good magnesia bricks from material which, at the outset, could hardly be considered of very promising quality in comparison with Grecian magnesite; and they succeeded so well that, at the outbreak of war in 1914, they were and had been for some years producing almost the whole of the world's metallurgical requirements of refractory magnesia.

It is therefore well worthy of note that a great deal of work has been done on the manufacture of magnesia bricks from magnesite of the Grecian and Salem (India) type long before the Germans began to supply the world's needs from the breunnerite deposits of Austria-Hungary. It is still more noteworthy from the ceramic point of view that the use of magnesite as a refractory appears to have grown as an offshoot of pottery manufacture, though its first employment for the latter purpose appears to have been associated with a mistake as regards its identity. The silicious magnesite of Baudissero in Piedmont is reported to have been used quite successfully in porcelain manufacture, at and previous to the beginning of the 19th century. This particular magnesite was at that time regarded as a high-class china clay (terra da porcellana) and was not known to contain any magnesia. Giobert analysed it and proved it to be a silicious magnesite containing no alumina. He mixed the magnesite with sufficient clay to secure a pasty consistency and made it into refractory crucibles (see *Journal de Mines*, 1806, 20, 118, 291). In the earlier half of the 19th century the French workers used magnesia crucibles for the fusion of platinum, and Regnault states that several of these magnesia crucibles were given to him by Thilorier and used during trials in the kilns of Sèvres.

In 1866 M. H. Caron (see *Comptes Rendus*, 1866) called attention to the value of magnesite as a source of refractory magnesia. At that time crude magnesite cost 250 francs per metric ton and was too expensive to use except on a laboratory scale. The Siemens-Martin process and the use of magnesium oxychloride cement were introduced about that date, or very shortly afterward. These doubtless created a larger demand and cheapened the rate at which the mineral could be obtained. When, two years later, Caron gave his account of a method of manufacturing magnesia bricks (see *Comptes Rendus* 1868, 66, 839) and emphasized their utility in the Siemens-Martin furnace, he stated that magnesite could then be obtained at the much cheaper rate of 70 francs per metric ton delivered at Marseilles and 100 francs delivered at Dunkirk.

One notes, therefore, as, a matter of considerable interest, that the raw magnesite used in those early days of magnesia-brick manufacture was of the compact (Grecian) type. Caron used Eubœan magnesite in making his bricks. Moreover, the compact magnesite of Frankenstein was used by Germans in making magnesia bricks at a much later date (see after), and that of Kraubat in Styria was known and used long before the Veitsch and other large Styrian deposits of breunnerite had been discovered. Caron's method of procedure was to dead burn the main mass of magnesite, after which it was readily broken to pieces so that the serpentine and quartz impurities could be separated. The product obtained was of a sandy, that is, crystalline nature, and as it would not bind alone it had to be mixed with caustic magnesia. Berzelius had previously indicated the property possessed by caustic magnesia of setting and hardening when moistened with water and afterwards dried, and it was this property that was taken advantage of by Caron. At a later date this property was accentuated by Sorel, who added the chloride and introduced the oxychloride cements. The proportion of caustic magnesia used by Caron depended on the temperatures attained in calcination; but for magnesite dead-burnt at the temperature of molten steel, the amount of caustic magnesia used was about a sixth of the weight of the dead-burnt magnesia used. The mixture was wetted with 10 to 15% of water and moulded under pressure, after which it hardened on drying and became very refractory when subsequently baked.

It was due to the early work of the Imperial Geological Survey of Austria in the fifties of last century that the various deposits of spathic breunnerite in Styria and Lower Austria were discovered, and first described by F. Foetterle, one of the pioneer geologists of that Survey. Up to that time the best known and most used of the Styrian magnesites was that of Kraubat, a vein deposit of the crypto-crystalline type, and of good quality, resembling that of Salem and Greece. The saccharoidal magnesite of St. Kathrein in Austria was also utilized in those days, and seems to have been made into refractory bricks. Foetterle had a sample of sintered magnesia and a magnesia brick in the Austrian Survey collection, and he appears to have fully appreciated the potentialities of Austrian breunnerite as raw material for the manufacture of sintered magnesia and magnesia bricks; but not until about a quarter of a century afterward was its utilization in any large way for these purposes commenced. In the meantime, and even afterward to some extent, the Germans appear to have followed the French practice in utilizing compact magnesite of the Salem and Grecian type for the manufacture of magnesia bricks. The process of manufacture described in Germany at a much later date follows closely that described by Caron. Here again we may note that, according to C. Bischof (see *Osterr. Zeit. f. Berg. u Hutt.* vol. 41, p. 27), the material used at Brieg in Silesia was the compact magnesite of Frankenstein, which resembled Grecian magnesite. The Brieg practice involved the use of caustic magnesia as a cement for the dead-burnt magnesia in making the bricks. Magnesium chloride was used in the cement, and the bricks were subjected to a pressure of 110 atmospheres in a hydraulic press. The bricks were then dried carefully in air, and as a result of this they assumed a denser and more compact character. After standing a week they were burned in a Mendesheim gas furnace on a floor of magnesia bricks.

The Brieg bricks had the following composition: Magnesia (MgO) 80·9%, lime (CaO) 6·5%, silica (SiO_2) 4·8%, alumina (Al_2O_3) 1·6%, ferric oxide (F_2O_3) 6·8%. According to Bischof, high pressure must be applied in moulding the bricks if cracking is to be prevented, and the drying should be done slowly. The bricks should be perfectly dry before they are baked. The baking should be carried out at a uniformly high temperature, and the bricks should be cooled as slowly as possible.

Wedding (see *Stahl und Eisen*, vol. 13, p. 279) states in his description of the Austrian method of manufacture that the bricks are moulded in a hydraulic press working at a pressure of 300 atmospheres. He attaches importance to the removal of dust from the sinter. The dust consists mostly of lime and is easily separated because it slacks readily. Unless it is removed this lime reacts readily with silica, and is therefore injurious if Dinas bricks are built directly upon it. For making a basic hearth of magnesia he states that a mixture of finely-ground sintered magnesia and basic open-hearth slag was used. The composition of the slag used was as follows: Silica (SiO_2) 10 to 15%, alumina (Al_2O_3) 2 to 3 %, lime (CaO) 18 to 30%.

F. Bleichsteiner also emphasizes the importance of removing lime from the sintered magnesia (see *Osterr.*

Zeit. f. Berg. u. Hütt, 1892, 40, 355). The dust obtained by screening sintered magnesite is according to him largely calcareous, and should be separated before the sintered magnesite is pulverized for use. He recommends the use of sintered magnesia alone, without the addition of a caustic-magnesia cement, in the manufacture of bricks. The Veitsch company claims to adopt this method

The possibility of brick manufacture from certain varieties of Austro-Hungarian dead-burnt magnesia without the use of cement appears to have been known for a long time. According to C. Schimm (see *Tonind. Zeit.*, 1905, Nos. 148 and 149), the magnesite of Mutnik in Hungary is specially adapted for use in this way, on account of its disseminated fibrous serpentine; but great elaboration in dressing appears to be necessary to reduce the amount of serpentinous impurity in the Mutnik material to the amount allowable in brick manufacture. Schimm states that the grains of pulverized sinter used in making magnesia bricks are screened to a limiting maximum size of about 2 mm. diameter.

Although the Veitsch company claims to make bricks without binder, and Bleichsteiner states that this is the preferable mode of procedure, the accounts of Schimm and other writers on this subject seem to indicate that the manufacture of bricks from sintered magnesia alone is exceptional.

In a very interesting paper published in 1908, F. Cornu (see *Centralblatt fur Mineralogie*, etc., 1908, p. 305) dealt with the texture and composition of Austrian magnesia bricks as revealed by the polarizing microscope. He described and figured the peculiar honeycomb-like texture shown by thin sections of the Styrian bricks. This texture he attributed to the fact that the constituent granules were faceted crystals of periclase (crystalline magnesia). Artificial periclase had, however, long been known to mineralogists; and the sandy or crystalline material obtained by dead-burning the compact magnesite of India and Greece was already known to French and English scientific workers as an artificial form of periclase.

Cornu made a careful physical and chemical study of the constitution of Austrian bricks, and showed that the periclase granules were crammed with opaque and very minute particles. From the analysis of sinter and bricks he inferred that these minute particles, which seemed to show a cubic shape, consisted of magnesioferrite ($MgFe_2O_4$), a member of the spinel group of minerals. He also inferred from an analysis of an Austrian brick, that the vitreous cement in that particular case, not reckoning the iron oxide, had approximately the composition: lime 29%, alumina 13%, and silica 58%. He further calculated that on the whole the brick consisted of about 94% of periclase, including the particles of magnesioferrite disseminated through it, and about 6% of vitreous cement (German, glaskitt).

There appears to have been much variety of practice as regards the nature of the binding material used in the manufacture of magnesia bricks. Reference has already been made to the use of hydrated caustic-magnesia with or without magnesium chloride. According to Bischof a little iron oxide, silica, or silicate may be added to modify the effect. In the case of the Mutnik magnesite already mentioned, the self-binding property is conferred by the disseminated fibrous serpentine present. A serpentine binder appears to have been used largely also in the manufacture of bricks from Grecian, Norwegian, and other magnesites. Clay to the amount of 15% or more is stated to have been used as a binder in some cases. Borax, dextrine, anhydrous tar, and other materials have also been used, and the Veitsch company is stated to have patented a mixture of dead-burnt magnesia, iron turnings, and lime.

The degree of shrinkage suffered by a moulded and pressed brick during its final bake seems obviously a very important matter. According to Schimm, the linear and volume shrinkages should not exceed about 5% and 15% respectively. The actual amount of this shrinkage depends on many factors, and requires careful control if the finished bricks are to be sound and of uniform size. Factors which would appear to be important in determining the degree of shrinkage are the temperature of sintering, the grain-sizes in the crushed sinter of which the bricks are made, the nature and amount of the binding material, the degree of the moulding pressure, and the temperature attained in the final firing operation. The apparent specific gravity of the crushed and roughly-sized sinter affords an indication of the thoroughness of the sintering, and the moulding pressure required to secure the proper amount of shrinkage in the finished product. It seems clear from the various descriptions given by different authors that the pressure applied in moulding the bricks is variable, and is regulated in accordance with the physical condition of the sinter from which the bricks are made.

We may sum up the views thus briefly reviewed as to the essential features of the manufacture of refractory magnesia as follows:

(1) The finished products, whether as sinter obtained by dead-burning the raw magnesite, or as bricks produced by a second or further burning of the pulverized compressed sinter, should consist essentially of crystalline magnesia. The Austrian practice aims at obtaining a sinter containing at least 83% of magnesia. Lime, silica, and alumina are regarded as undesirable ingredients and should not exceed 5%, 6%, and 2% respectively. Iron oxide is regarded as a desirable ingredient, but the amount of ferric oxide is not allowed to exceed 11% or so of the sinter.

(2) The dead burning of the raw magnesite should be effective, since it is only the inert and comparatively dense, crystalline product (periclase), into which caustic magnesia becomes transformed by prolonged heating at temperatures upwards of 1,400°C. that can be regarded as refractory. The kiln temperature required varies with, and must be adapted to, the nature of the raw material. The temperature required for the sintering of Styrian magnesite is said to range from 1,400° to 1,600°C., the average being about 1,500°C., while that required for Grecian magnesite is stated to be much higher; but there appears to be scope for useful investigation on this subject.

(3) The production of good magnesia bricks demands the use of pulverized sinter of good quality. The sizing of the grains, the nature and proportionate amount of the binder used where such is necessary, the pressure under which the bricks are moulded, the drying conditions, all these are controllable factors, and appear to be taken carefully into account in the Austro-Hungarian process of brick manufacture. The aim in this process seems to be to secure bricks the volume-shrinkage of which in the final burning operation does not exceed about 15%, and the nature of which renders them immune from any considerable shrinkage under the furnace conditions for which it is designed to use them.

The manufacture of refractory magnesia thus clearly gives great scope for technical skill in management at every stage, from the careful dressing of the raw material and sintered product up to the production of finished bricks. It seems necessary to emphasize the importance of securing uniformity of quality in the raw material, since otherwise a manufactured product of standard quality can hardly be obtained. One may safely infer that, of the various factors which have contributed to the success of the refractory-magnesia industry of Austria-Hungary, one of the most important has been the careful standardization of the finished products, such as can only be attained by dressing the raw magnesite and dead-burned magnesia so as to yield materials of steady quality.

Reference to recently published papers is avoided in this brief review, which, as a preface to the study of raw magnesite, aims merely at defining the requirements to which the raw material should conform. The refractory magnesia of commerce is in the form of either sinter or bricks, and, in dealing with the raw material, we do well to keep prominently before our minds the standard aimed at in the manufactured products, for only by so doing can we judge as to the relative merits of the different kinds of raw magnesite.

MINERALOGY OF MAGNESITE.—Magnesite is one of a group of simple rhombohedral carbonates of which the most important from the refractories standpoint are calcite ($CaCO_3$), magnesite ($MgCO_3$), and chalybite ($FeCO_3$). These carbonates are closely similar to each other in their crystalline structure and symmetry, and their crystals are all characterized by three perfect cleavages, which cause them to split readily into rhombohedral fragments, such as we are familiar with in calcite and spathic iron carbonate. The polar (obtuse) angles of these rhombohedral cleavage fragments measure 105° 5′ for calcite, 107° 29′ for magnesite, and about 107° for chalybite.

The specific gravities for cleavage fragments of the three minerals are 2·72 for calcite, 3·02 for magnesite, and 3·88 for chalybite; and the molecular volumes are 36·8, 27·8, and 29·9 respectively. We may note that the polar angles and molecular volumes of magnesite and chalybite are in comparatively close agreement with calcite. In close correspondence we have the further facts that calcite and magnesite show only imperfect isomorphism, whereas the isomorphism between magnesite and chalybite is fairly perfect. A study of the isomorphism of the rhombohedral carbonates would take us too far from the purpose of this paper; but the subject is one deserving of notice by anyone interested in the mineral associations of magnesite considered as raw material from the refractories point of view.

The molecules of calcite and magnesite do not mix to form a well graded isomorphous series. On the contrary they mix in the ratio 1 : 1 to form the mineral dolomite, $CaMg(CO_3)_2$, which is usually regarded as a molecular compound. We find, moreover, that when a dolomite rock contains calcium carbonate in excess of this ratio, the excess is present in the form of separate grains of calcite, which can often be mechanically separated from the dolomite. Impure dolomites of this kind are of very frequent occurrence, and may be described as calcitic dolomites of dolomitic limestones, according to which constituent is dominant. Similarly, when a dolomitic rock shows magnesium carbonate in substantial excess of the above-mentioned ratio, this excess is present not in a state of homogeneous admixture, but as separate grains of magnesite which can be mechanically separated from the dolomite. These facts concerning the petrology of dolomite and magnesite are easily intelligible when considered from the standpoint of the imperfect isomorphism of calcite and magnesite.

When we come to deal with mixtures of magnesium and iron carbonates, however, we find a very different state of things. The union of these two carbonates in a definite molecular ratio, as in pistomesite, $Mg.Fe(CO_3)_2$, is unusual and merely accidental. Moreover, an excess of either the magnesium or ferrous carbonate over the amount required by this ratio is present as a homogeneous mixture, and not as a mixture of grains which can be mechanically separated. Breunnerite, the variety of magnesite from which Austro-Hungarian refractory magnesia is made, contains a variable percentage of ferrous carbonate in a state of isomorphous (homogeneous) admixture. This homogeneous condition of the breunnerite used in the manufacture of Austrian bricks is regarded as a feature of capital importance from the refractories point of view.

The terminology of the magnesite-chalybite series requires to be defined. The series is an important one from the economic standpoint, the chalybitic members as iron ore and the magnesitic members as refractories. In view, therefore, of the perfect isomorphism prevailing throughout the series, its subdivision on a definite basis seems clearly desirable. Perhaps the most convenient way in which this can be done, having regard to the meanings of mineral names already in use, is to subdivide on a percentage basis, as follows:

	$MgCO_3$ per cent.	$FeCO_3$ per cent.
Magnesite	100 to 95	0 to 5
Breunnerite	95 to 70	5 to 30
Mesitite	70 to 50	30 to 50
Pistomesite	50 to 30	50 to 70
Sideroplesite	30 to 5	70 to 95
Chalybite	5 to 0	95 to 100

By this arrangement the names magnesite and chalybite are kept for the pure or almost pure carbonates, the limit of ferrous oxide and magnesia impurities respectively being about 3%. The names mesitite, pistomesite, and sideroplesite are here used in broader senses than is usual, but in such a way as to include the particular molecular mixtures to which the names have hitherto been largely restricted. It is convenient to use the name breunnerite in a definite sense, and the sense in which the name is here used includes the type breunnerite originally described by Haidinger. The typical magnesite used for the manufacture of refractory magnesia in Austria-Hungary is also included under breunnerite, and it is quite useful from the refractories point of view to distinguish this material from the purer crystalline magnesite.

Without going into further detail concerning the rhombohedral carbonates, we may, for our present purpose, enumerate the chief members as follows:

	Formula	Sp. gr.
Calcite	$CaCO_3$	2·72
Dolomite	$CaMg(CO_3)_2$	2·85
Ankerite	$2CaCO_3Mg(Fe)CO_3$	3·05
Magnesite	$MgCO_3$	3·02
Breunnerite, Mesitite	$Mg(Fe)CO_3$	3·01 to 3·45
Pistomesite, Sideroplesite	$Fe(Mg)CO_3$	3·45 to 3·08
Chalybite	$FeCO_3$	3·88

The specific gravity given above for magnesite as 3·02, is approximately accurate at the second decimal place for rhombohedral cleavage fragments of fairly pure magnesium carbonate. The specific gravity of the compact variety is always lower than this, and rarely exceeds 2·95. Values exceeding 3·02 for rhombohedral cleavage fragments free from pyritic and other such impurities indicate the presence of ferrous carbonate. Breunnerite has an average specific gravity of about 3·15.

An important fact concerning breunnerite is the conversion of the ferrous carbonate into a magnetic oxide on ignition in a reducing atmosphere. This is the cause of the blackness and magnetic character of the dead-burned magnesia from which Austro-Hungarian bricks are made. In this respect breunnerite behaves like ankerite.

Much has been said concerning the part played by iron oxide in determining the comparative efficiency of Austrian dead-burnt magnesia both in the sintered and brick form. On this point we may here note that the virtue of the iron oxide in Austrian sinter lies in its binding and not in its heat-resisting properties. This binding effect is due to the comparatively low melting point of the iron compound formed. It is for this reason necessary to keep down the iron oxide percentage of the sintered product, in order to secure the binding effect without any serious sacrifice of refractoriness. We may note further that the blackness and magnetic permeability of the dead-burnt breunnerite facilitates dressing operations, and therefore makes possible the careful standardization of the product.

The dissociation temperatures of the rhombohedral carbonates have not been as fully investigated as they should be from a practical point of view, for they obviously have an important bearing on the question of effective burning. According to Brill the dissociation temperature of magnesite is 445°C., whereas that of calcite is 825°C. Complete decomposition, however, requires higher temperatures than these, and depends to some extent on the physical condition of the mineral.

Chalybite appears to have a rather lower dissociation temperature than magnesite. According to Akermann it dissociates between 300° and 400°C., and so far as this may be of significance it operates in the direction of greater economy in the calcination of breunnerite as compared with purer magnesite; but it is perhaps not of much practical importance. The opposite effect of an appreciable percentage of calcite or dolomite must be of larger significance.

More important, perhaps, is the question of thermal conductivity. There is probably little difference of thermal conductivity between breunnerite and pure magnesia in the raw state, but the transformation of ferrous carbonate into magnetic oxide in the calcination of breunnerite might be expected to increase the conductivity substantially. This and the reaction of the iron oxide with the magnesia to form magnesioferrite in the sintered product are doubtless factors of much significance in the readier dead-burning of breunnerite as compared with ordinary magnesite. The actual temperature of transformation of caustic (amorphous) into crystalline magnesia appears not to have been determined.

Calcined magnesite of the compact or Grecian type often shows a columnar structure, while spathic magnesite on the other hand retains its cleavage form when calcined, and shows rhombohedral fragments even in the sintered state. This feature is of some importance as regards the behaviour of the magnesite in the kiln.

The hardness and toughness of magnesite are variable. Spathic magnesite has a hardness of about 3½. The compact variety is usually a little harder and may have a hardness of 4 or more according to the degree of silicification.

Spathic magnesite, on account of its ready cleavage, is easily broken up and ground, specially when it is coarsely crystalline. Compact magnesite of the vein type is sometimes brittle and may break with a conchoidal fracture. Nodular varieties on the other hand are apt to be very tough, and some kinds extremely so, presumably owing to their more complex texture. Compact vein magnesites are sometimes very tough, especially when, as in specimens obtainable from the magnesite of Kaapmuiden in South Africa, a considerable percentage of free silica is present in the form of a skeleton of quartz.

CLASSIFICATION OF MAGNESITES.—From the economic standpoint, perhaps the best way to classify magnesites is on the basis of texture and composition as follows:

(1) Spathic breunnerite, example, Styrian;

(2) Spathic magnesite, example, Quebec, Washington, and Norwegian;

(3) Compact magnesite, example, Grecian, Californian, Italian, Indian (Salem) and Australian;

(4) Hydromagnesite, example Atlin in British Columbia.

Spathic is a convenient descriptive term for those comparatively coarsely crystalline magnesites and breunnerites the constituent grains of which show cleavage. Compact or crypto-crystalline magnesite shows no cleavage, but it is generally firm in texture. Hydromagnesite is powdery or very friable.

It is of interest to note that differences in texture among magnesites correspond to differences in chemical composition. Raw spathic magnesite or breunnerite usually contains much more impurity than raw compact magnesite. Breunnerite is usually coarse in texture, and, as we have seen, is characterized by a considerable percentage of ferrous carbonate isomorphously mixed with the magnesium carbonate. Spathic magnesite is usually less coarse in texture, and is almost free from admixture with ferrous carbonate.

Spathic magnesite and breunnerite generally occur in association with dolomite, and are therefore liable to contain much lime impurity. The admixture of this dolomite is less intimate in coarse-textured spathic breunnerites of Austria than in the closer-textured spathic magnesite of Quebec. Partly for this reason, and partly owing to the isomorphously mixed ferrous carbonate, the dressing of breunnerite and elimination of the dolomitic impurity is economically more feasible than in the case of the purer spathic magnesite.

Compact (cryptocrystalline) magnesite frequently includes an admixture of quartz, serpentine, or repiolite, and is therefore liable to contain silica impurity; but except where its conditions of occurrence have allowed the infiltration of calcium carbonate, it is as a rule fairly free from lime impurity. This absence or low percentage of lime and iron renders it eminently suitable for the production of caustic magnesia as used in the manufacture of oxychloride cement, refractory paint, etc.

The following generalized analyses illustrate the chemical differences among these various types of dressed raw magnesite:

	Spathic breunnerite. Austria	Spathic magnesite. Quebec. Norway and Washington	Compact magnesite. Greece. India, and California	Hydromagnesite. Atlin, British Columbia
	%	%	%	%
Magnesia	38 to 44	38 to 47	47	[illegible]
Lime	1 to 3	0 to 10	[illegible]	[illegible]
Ferrous oxide, Alumina	2 to 7	[illegible]	1	[illegible]
Silica	1 to 5	[illegible]	[illegible]	[illegible]
Carbon dioxide	[illegible]	[illegible]	50	6
Water	—		—	19

The Austro-Hungarian material varies from pure magnesite to breunnerite, but consists predominantly of spathic breunnerite.

The large variation in the lime percentage of spathic magnesites is due to varying amounts of dolomite. Norwegian (Snarum) magnesite contains no lime. The material marketed in Washington State (U.S.A.) at the present time contains not more than about 2% of lime. Quebec magnesite (near Calumet), on the other hand, contains a considerable amount of dolomite and ranges up to 10% or more of lime.

Compact magnesite generally contains very little lime; but much Italian and some Grecian magnesite contains above the normal percentage, due presumably to the presence of calcite, which has found access to the veins through the medium of infiltering calcareous solutions that have traversed adjacent masses of chalk or limestone.

The hydromagnesite of Atlin is remarkable for its low percentage of impurities.

Fuller details of these and other magnesite deposits will be given later.

(To be continued).

NICKEL IN SOUTH AFRICA.

Last year we quoted a number of articles by Dr. P. A. Wagner, published in the *South African Journal of Industries*, describing the resources of the Union in the way of mineral deposits. The November issue of the journal contains another article on this subject. This is by T. G. Trevor, Inspector of Mines, and deals with nickel

This metal has been reported from six quarters: (1) Insizwa, on the boundary between East Griqualand and Pondoland; (2) Vlakfontein No. 902, Rustenburg, Transvaal; (3) Derde Gelid No. 141, Lydenburg, Transvaal; (4) Blaauwbank No. 433, Waterberg, Transvaal; (5) The Cobalt Mines, Kruis River No. 65, North Middelburg, Transvaal; (6) Zululand, Nkandhla District, Umhlatuzi River. The fourth and fifth of these occurrences appear to be irregular pneumatolytic impregnations connected with the bushveld granite and not to give promise of magnitude or permanence, but the first two have immense possibilities, while the third and sixth may also, on investigation, prove to be of importance.

The deposits of the Insizwa Range are fully described by A. L. du Toit, Geologist to the Union Government, in the Annual Report of the Geological Commission for 1910, and in "The Geology of Part of the Transkei," "Explanation of Sheet 27, Cape-Maclear Umtata," published by the Government Printer, Pretoria, 1917; also by W. H. Goodchild in his paper, "The Economic Geology of the Insizwa Range," published in Bulletin No. 147 of the Institution of Mining and Metallurgy, December 14, 1916. Both these writers agree in their description of the geology of the district, from which it appears that the Insizwa Range consists of mountains rising to about 6,000 ft. above sea-level and 3,000 ft. above the surrounding country, formed by a norite-gabbro sheet from 1,000 to 3,000 ft thick, which has metamorphosed the underlying shales into hard hornfels. The base of the gabbro mass dips inward in all directions from the margin, so that the lower surface of the igneous rock clearly must be basin-shaped. The sheet exhibits in a clear way the results of magmatic differentiation, whereby picrites, rocks rich in olivine, have crystallized toward the bottom of the sheet, the material showing a decreasing basicity toward the summit of the mountain. The specific gravity of the lower picrites are from 3·1 to 3·27, while that of the overlying norites diminish to 2·9 toward the summit of the mountain. Along the outcrop of the margin, between the contact of the gabbro and the underlying hornfels, sulphide ores have been discovered at various places, and a considerable amount of prospecting has at one time or other been done. In most instances this work has been put in wherever the rocks were found stained green with carbonate of copper, or probably also with garnierite. The ore occurs in small veins up to two feet in thickness, and also disseminated throughout the rock. Three minerals make up the ore patches, pyrrhotite, chalcopyrite, and pentlandite, the latter being the nickel bearer. Niccolite and bornite have occasionally been observed. Gold and the platinum group of metals also occur. There is every stage from gabbro or norite, with minutely scattered particles of ore, to a rock in which the ore and the silicates are in equal amounts, and finally to a nearly pure ore, with a few patches of silicates scattered through it. These rich sulphide-bearing rocks commonly give rise to sheet-like bodies running along, or roughly parallel to, the contact, and fading into gabbro nearly devoid of ore. As regards the richness of the deposits, little can be said, as most of the assays were made upon the vein-like bodies of ore, but the copper and nickel seem to be present in almost equal amounts, totalling perhaps from 2 to 3·5% of metals in the disseminated ores, while the platinum may run from ½ dwt. to 1 dwt. per ton in the richer samples.

Both authors have come to the independent conclusion that the ore-bodies are likely to be richer and larger toward the centre of the basin, or, more correctly, basins, as the deposits are not limited to one mountain. This indeed seems probable, for, granted that the segregation of the ore was assisted by gravitation in the lower portion of the mass, then that segregation would certainly be more pronounced in the centre of the basin, and it is possible that only the edges of the mineralized zone are exposed, and that driving deep into the mass toward the bottom of the basin may disclose bodies of ore of undoubted payability.

The nickel deposits on Vlakfontein No. 902, and its neighbourhood, in the Rustenburg district of the Transvaal, have not yet been the subject of a scientific description, but on Vlakfontein itself a considerable amount of prospecting work has been done by Messrs. Chudleigh and Harding, and the conditions may be described as follows: Lying in the centre of the Transvaal is a huge laccolite of red granite, intruded between the Pretoria series and the Waterberg formation. The actual granite to-day covers an area of the shape of an irregular oval stretching from M'Pathalele's Location in the east to Pilandsberg in the west, and from a point about twenty miles north of Pretoria to Warmbaths in a northerly and southerly direction. This mass is surrounded by a marginal fringe of norite and basic rocks; usually this fringe is about six miles in width, but to the west it spreads out to a maximum width of some seventy miles. The total area of the laccolite is given by Hatch and Corstorphine as 15,000 square miles, of which the marginal norites make up at least 5,000. Vlakfontein lies in this marginal zone of norites and pyroxenites, but some ten miles to the north-east the laccolite is broken through by the great eruptive volcanic mass of the Pilandsberg. In the neighbourhood of the farm the country is flat and slightly undulating; on it several lines of small, ancient workings were noticed, and attracted the attention of prospectors. On opening these, copper ores were found, and it was obvious that the outcrop gossan had been worked for copper.

Four shafts have been sunk, the total length of outcrop covered being approximately 900 yards, and a considerable amount of other prospecting work has been done. The gossan outcrops occur intermittently in three roughly parallel lines across the farm, appearing to stretch many miles to the north, at least as far as Groenfontein No. 302. Where these outcrops have been opened by the shafts, the general experience has been that down to forty feet the gossan is ill-defined, but approximately vertical, and carries nothing but traces of copper, with occasional blocks of unaltered sulphide ore. From that depth nickel appears in conjunction with the copper as an irregular impregnation, but in the neighbourhood of 100 ft. this nickel-copper impregnation is distinctly richer than at 50 ft., and covers larger areas. In no case has work been carried below the 100 ft. level, as at that level the permanent water level is reached.

In No. 1 shaft at the 55 ft. level an area 10 ft. by 30 ft. is impregnated with nickel-copper, giving an approximate plan area of 300 sq. ft., assaying 0·74% nickel and 0·25% copper. At the 71 ft. level the plan area of ore matter is 480 sq. ft., giving a value of 1% nickel and 0·2% copper. At the 85 ft. level the metalliferous area exposed is 500 sq. ft., assaying 1·97% nickel and 4% copper. No. 2 shaft is carried to the 64 ft. level. At the level a drive traverses 25 ft. of ore matter, which a cross-cut shows to extend about 15 ft. in width. This assays up to 0·57% nickel and 6% copper. No. 3 shaft is situated on the same line as No. 1, 734 yards to the west. In this case no ore was struck on the surface, but at the 56 ft. level a block of ore-bearing matter, approximately 30 ft. by 20 ft., was traversed in a cross-cut. The average assay of this matter was 3·25% nickel and 0·66% copper. No. 4 shaft is situated on a line intermediate between shafts Nos. 1 and 2. At 50 ft. ore was encountered for the first time. A level driven at 72 ft. exposed an area of ore of about 2,156 sq. ft. in extent, the average values being 2·3% nickel and 0·9% copper. At the 96 ft. level the area of ore-bearing matter was 58 ft. by 57 ft., equalling 3,306 sq. ft., the average value being 2·01% nickel and 0·7% copper. At both the above levels considerable cross-cutting was done, which proved the actual extent of the ore-bearing matter.

Mr. Trevor did not observe in the ore bearing bodies obvious brecciation, but they are distinctly fissured both vertically and horizontally, having a tendency to break up into brick-like pieces. He is not in possession of the results of any microscopic examination of the ore-body, but it appears to consist of pyroxene, accompanied by various quantities of pyrrhotite and chalcopyrite; whether pentlandite is also present has not yet been proved. Some tests of the ore carried out by Professor Stanley in 1913 showed that concentration of the ore was difficult, and that the ore in its raw state was very infusible, but that a partial roast and subsequent fusion produced a button of nickel-iron matte equal to 27% of the weight of the ore, under a well-fused black slag, without the addition of any extraneous flux. As in the case of both the Sudbury and Insizwa deposits there seems to be no definition of the ore bearing masses; they simply fade away into the surrounding country.

On visiting the underground workings, the most striking feature is the speed at which oxidation and leaching take place. Rock, which has only been broken for a few months, has changed colour and become covered with an efflorescence, and drives only a few months old are similarly coated. A sample of this efflorescent material taken by Mr Trevor and submitted to the laboratory of the Geological Survey gave, when tested, strong nickel reactions. It is therefore obvious that the nickel contents are solvent under the action of surface waters, and it is highly probable that beneath the level of permanent water the ore-bodies will be found distinctly richer. In the report on the nickel industry issued by the Canadian Department of Mines in 1913, page 28, special attention is called to the solubility of the nickel minerals, and it is noted that the products are all of a very fugitive description, a permanent secondary compound of nickel or a secondary enrichment of nickel minerals not having been encountered in the Sudbury district. It must be noted, however, that the region in which the Sudbury deposits occur has been subject to glaciation, and that the climate is a very humid one. The present land surface of Vlakfontein is, on the other hand, an extremely ancient one, and has suffered from little or no denudation. The climate also is semi arid, and most of the water falling as rain does not run off either on the surface or through underground channels, but is accounted for by evaporation, conditions which are very much more favourable to the formation of secondary enrichments than those prevailing in Ontario.

In a check assay of a sample submitted to the Geological Survey, gold to the extent of 9 dwt. to the ton was obtained, but no platinum. The presence of the platinum group of metals has, however, frequently been recorded by other assayers.

Though the nickel deposits on Vlakfontein do not occur actually on the lower margin of the norite-pyroxenite mass, they are certainly near it. Across the surface it is about 3,000 yards to the hornfels underlying, but it is impossible to state what the thickness of the norite may be. The dip of the hornfels is very slight, and it is quite possible that the surface of Vlakfontein may be only a few hundred feet above the actual contact of the rocks. Speaking generally, there is an obvious similarity between the conditions under which the nickel is found at Vlakfontein and in the Sudbury area, and, if work is continued below water-level into the zone unaffected by surface leaching, there is a distinct probability that ore-bodies of undoubted payability and great extent may be discovered, and if discovered in one place only there will be encouragement to open many other places on the line where similar surface conditions prevail. It is therefore extremely unfortunate that prospecting work should have stopped where it did. If only one shaft were continued for a couple of hundred feet below water-level some definite result would have been obtained. If once it is proved that the ore increases in value and extent with depth to a point which places its payability beyond doubt, then there is room for indefinite expansion in the great areas along which similar surface indications exist.

Derde Gelid No. 141, Lydenburg, is situated geologically on the same horizon as Vlakfontein, but lies in the norite-pyroxenite fringe at the opposite end of the laccolite, some 200 miles to the east of that farm. Old workings exist showing an extensive gossan. In assaying this gossan, copper and traces of nickel were discovered, but no further work has been done. Should, however, developments on Vlakfontein be favourable, there is no doubt but that exploration work on this farm will be justified. It may also be mentioned that in very many places on the norite margin of the bushveld laccolite the author has observed ancient workings, presumably for copper, around which the geological conditions are similar to those at Vlakfontein and Derde Gelid, and which, on investigation, may also prove to be nickel-bearing.

The occurrence of nickel in Zululand is recorded by C. J. Gray in the Report on the Mining Industry of Natal for the year 1899. The discovery of nickel in Zululand is in a large body of serpentine in the Nkandhla District on the south bank of the Umhlatuzi River, close to the copper-bearing syenite and native workings for iron previously mentioned. The nickel is in the form of garnierite. It is widely distributed in the serpentine, being indicated by the bright green colour it gives to the rock, but so far no portions have been opened showing the mineral in payable quantities. Some of the samples show an imperfect schistose structure in the serpentine, with the nickel mineral apparently most concentrated in particular planes. The serpentine carries as a mass about the same proportion of nickel as that in New Caledonia, the French Island in the Pacific.

The Deloro Metallurgical Works.—The *Bulletin* of the Canadian Mining Institute for December contains a description by Sydney B. Wright of the metallurgical works of the Deloro Reduction Company, particularly in connection with ore and other products received from mines at Cobalt and Gowganda. These materials consist of high and low grade silver-cobalt ore in lump form, jig and table concentrates, and ore residues such as those produced by the Nipissing Mining Company and the Mining Corporation of Canada.

For sampling purposes the ore is ball milled to about a 20 mesh product, a 14% cut being drawn by a Snyder disc machine as the bulk sample. After a second Snyder cut, the sample, now constituting about 2% of the original ore, is transferred to the sampling floor, where, after thorough mixing, it is coned and quartered into two samples which are then quartered down separately. Reserve samples of these original pulps are sealed and retained for umpire purposes, until settlement has been made for the shipment. The control samples are ground to pass a 100 mesh screen, scales being separated as usual for assay purposes. The requisite number of assay samples are drawn for the shipper, smelter, and independent assayer; the certificate of the last governs in settlement for the shipment. Metallics or nuggets are removed from the ball-mill after the carload or lot has been crushed, and are melted down to base bullion in an oil fired crucible furnace. The silver content, as shown by assay, is added to the total silver contained in the milled pulp, and settlement made accordingly.

After the ore is sampled it is transferred to bins, from which it is charged to the blast-furnace. The charge is so calculated as to furnish a practically neutral slag and, on account of the large quantity of fines present, the furnace is run generally at a blast pressure of only 6 to 8 oz. It was considered probable that by briquetting the fines the capacity of the furnace would be increased, but the test runs made on these lines did not produce the desired metallurgical results. The ore, and reverts from other sections of the plant, are therefore mixed wet and charged to the furnace in the form of a stiff mortar; this sinters fairly well before the smelting zone is reached, the actual flue dust produced amounting to about 6% of the ore and slime charged. The products of the smelting operation are speiss, from which a quantity of base silver is liquated in the case of high-grade runs, slag, and arsenic fume, which is collected in bag-houses of the regular type.

The speiss contains approximately: Co, 22 to 25%; Ni, 16 to 18%; As, 25%, Fe, 18%, S, 7%, Cu, 1%, Ag, 1,000 to 1,200 oz. per ton. This is ground in a ball-mill until the whole passes a screen with 40 meshes to the inch. The ground material is then roasted until it contains only 10% of arsenic. The roasting is done in a furnace of the reverberatory type, which is equipped with a mechanical rabble having water-cooled arms. The chloridizing is done in a Bruckner cylinder. The chloridized speiss is washed with water and then agitated for one hour with a cyanide solution containing the equivalent of 20 lb. KCN per ton. The silver is precipitated from the solutions by means of aluminium dust, one part of which deposits about eight parts of silver. It is interesting to note that the cyanide actually regenerated in this precipitation is practically equal to the theoretical quantity formerly present in the double silver salt. The precipitate now goes to the silver refinery and the desilverized speiss residues to the oxide plant.

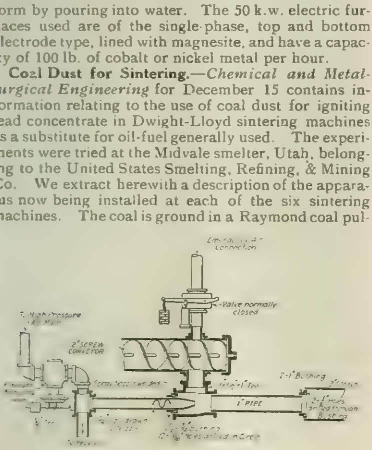
The base silver, liquated in the form of bottoms from pots of speiss, averages about 800 fine, the balance consisting of arsenic and antimony, with some cobalt, nickel, iron, copper, and bismuth. This bullion is refined by melting it in an oil-fired Schwartz furnace, which is equipped as a small converter. As soon as the charge is in a molten state, the furnace is tilted backward into blowing position, and the metal is blown for about three hours. During the first half-hour of this period the oil is shut-off from the burner, the heat of the reaction being sufficient to keep the metal molten for that length of time. After a short further heating up, the charge is poured into ingot moulds. The silver bullion thus obtained averages from 992 to 995 fine, and is brought up to commercial grade (996 and better) by re-melting with silver precipitate from the cyanide plant; this operation is performed in a second Schwartz furnace. The gases from these furnaces are drawn through coolers and passed to a small bag house. The fume is rich in silver, carrying about 800 oz. per ton, and consists essentially of arsenious oxide with some antimony and bismuth oxides. All bullion slags and this fume are eventually re-charged to the blast furnace. The gases from the blast-furnace, the roasters, and chloridizers are drawn through flues and coolers before reaching the bag-houses which collect the crude arsenious oxide. The temperature of the gases entering the bag-houses is regulated at a maximum of 250° F. by means of a thermostat operating a damper in the main flue; when the temperature rises to 250° F. cool air is immediately drawn in, reducing the temperature.

The crude arsenic that is collected in the bag-houses is sent to refining furnaces, which are coke-fired reverberatory hearths. The arsenious oxide that is formed is volatized and condensed in chambers that are emptied at intervals of ten to fourteen days. The products from these chambers are pulverized and packed in barrels by means of a Raymond pulverizer, a system that certainly deserves the admiration and gratitude of the packer and his employer when handling such materials as arsenious oxide. The clinker or slag drawn from the refining hearth contains all the silver that was formerly present in the crude arsenic; this slag goes back to the blast-furnace.

It is necessary now to return to the desilverized speiss residues which contain the cobalt and nickel values of the ore. The metals in this material are present principally in the form of oxides, so the first treatment is that of sulphatizing in order to render the cobalt and nickel soluble as sulphates. The sulphatized speiss is charged to vats in which the mass is agitated with hot water and the sulphates dissolved. The liquors thus obtained are then freed from copper and iron before being passed to the precipitation vats. The cobalt and nickel are separated by fractional precipitation with hypochlorite solutions, the nickel being finally precipitated as hydroxide by means of milk of lime. The hydroxides of cobalt and nickel thus obtained are filter-pressed, washed, and dried; after which treatment the oxides are either pulverized and packed for the market, or are transferred to the metals department for reduction to the metallic state.

For the purpose of reducing the oxides they are mixed with charcoal and reduced to rough metal in oil-fired furnaces. After separation from excess carbon by means of a magnetic separator, the rough metal is melted in electric furnaces and converted into shot form by pouring into water. The 50 k.w. electric furnaces used are of the single-phase, top and bottom electrode type, lined with magnesite, and have a capacity of 100 lb. of cobalt or nickel metal per hour.

Coal Dust for Sintering.—*Chemical and Metallurgical Engineering* for December 15 contains information relating to the use of coal dust for igniting lead concentrate in Dwight-Lloyd sintering machines as a substitute for oil-fuel generally used. The experiments were tried at the Midvale smelter, Utah, belonging to the United States Smelting, Refining, & Mining Co. We extract herewith a description of the apparatus now being installed at each of the six sintering machines. The coal is ground in a Raymond coal pul-



COAL DUST FEEDER.

verizer, and is delivered by 4 in. screw conveyors to small steel hoppers at each furnace. From 450 to 500 pounds of pulverized coal per day will suffice to operate each roaster, in place of 70 gallons of fuel oil A small variable-speed motor is belted to a reduction-gear driving at 30 to 40 rotations per minute a 2 in. worm passing through the bottom of the hopper containing pulverized cool. The coal delivered by the worm drops through a 1 in. pipe into a tee, where it meets a stream of compressed air at from 12 to 20 lb., and is then blown into the burner and ignites. The compressed air is taken from the regular service lines for pneumatic tools, at 90 lb. pressure, through an adjustable pressure-reducing valve. An air receiver, consisting of an ordinary domestic hot-water tank, is tapped on the line near this point to absorb pulsations in the air supply. The bushings at both mixing chamber and burner are drilled with a number of small holes so that auxiliary air may be drawn in as desirable. A helical screw is fixed in the line just before the mixing tee so that the whirling air may expand into a wide spray. In operation the mixture of air and coal is ignited by some burning waste until the muffle becomes hot enough to maintain the flame near the end of the 2 in. pipe sleeve. It is stated that with some ore mixtures the pulverized coal gives a better cake than oil, as the oil flame apparently fuses the top surface, thus restricting the air-flow necessary for roasting and agglomerating the deeper layers.

The Lahat Co.'s Tin Mine.—The *Federated Malay States Chamber of Mines Magazine*, No. 7, 1918, published an account of a visit paid by members of the Chamber to the alluvial mines of the Lahat Mines, Ltd., one of the group working on the west side of the Kinta valley, Perak. The visitors were conducted over the property by T. R. A. Windeatt, the manager for Osborne & Chappel, and R. P. Brash, the first manager, gave an account of the early history of the mine.

It has been proved by the ancient mining tools unearthed that the hills around Lahat were first mined by the Siamese before the Chinese, who came to Kinta from Larut, had discovered this district. Some 10 or 15 years ago the land which was originally granted to the late Captain Ah Quee, father of Chung Thye Phin, was sublet to Foo Choo Choon, who worked the land with considerable profit to himself by shafting and other means. The mine was floated as a company in London by E. G. Edgar and W. A. Luning, and, as mentioned, R. P. Brash was the first manager. At that time the tin was mainly won from shafts which were sunk to a depth of 140 ft., but the open-cut system of working was introduced, and operations have been continued on that principle up to the present time.

The main lead, which strikes north and south, is the chief ore-body, and is situated at the contact of the granite of the Kledang range with the limestone which forms the bedrock of the alluvial flats of the Kinta valley. The present open cut mine has the decomposed granite hill, which rises about 300 ft. above the valley level, as the west wall, and it has been sunk to a depth of 145 ft. Limestone pinnacles may be seen outcropping on the west side of the mine, but bores that have been sunk on the main lead have failed to reach bedrock at a depth of 250 ft. below the surface. Ore from the main lead is notable for its exceptional purity, and is entirely different from that obtained from the east side of the mine. According to Dr. W. R. Jones, late Assistant Government Geologist, the ore of the main lead is derived from the decomposition of schists and phyllites in situ, while that overlying the limestone is the alluvium common to most of the Kinta valley.

At the main mines, karang is raised to the puddlers in trucks up two inclines, each served by a 40 b.h.p. electric winch. Mechanical counters, which are connected to all the winches, keep an accurate account of the number of truck trips. A recording ammeter in the power house is also connected to the winch motor circuits, and the chart gives the time of each truck trip, the number of trips, and a rough indication if the trucks are improperly filled. A 160 b.h.p. suction gas engine drives four slow-speed horizontal puddlers and an 8 in. water pump; another 8 in. water pump is driven electrically. The sluice-box, which is 15 ft. wide and 160 ft. long, is supplied with 220 cubic feet of water per minute, which is the total quantity available for washing the 16,000 cubic yards of karang per month from the main mine. The tailing from the sluice-box is lifted by an 8 in. gravel pump to the dump.

A second mine, called the New Area, has been opened to the south, and a hydraulic gravel pumping plant has been installed. Two 5 in. two-stage Worthington pumps, driven by 20 b.h.p. motors, supply 65 cubic feet of water per minute to each of two monitors having $1\frac{3}{4}$ in. nozzles at a pressure of 30 to 35 lb. per square inch. The monitors treat about 18 cubic yards of sandy solids per running hour. A 6 in. Thompson gravel pump, driven by a 40 b.h.p. electric motor, lifts the water and solids 44 ft. to the sluice box with an overall mechanical efficiency of 33%. The tailing from the sluice-box is again raised 45 ft. by the 8 in. tailing pump to the dump, making the total lift 89 ft.

Normal seepage water is lifted by a 16 in. Victoria-Turbo Boving pump coupled to a 180 b.h.p. motor working at 2,000 volts; the pump has a maximum capacity of 100,000 gallons per hour at 1,450 r.p.m., and is at present lifting to a height of 126 ft. This pump is situated above the floor of the mine. The small quantity of water entering the low levels is raised by a 4 in. electric pump. Rain water is raised by one of the two stand-by pumps which lift directly from the bottom level. The particulars of these pumps are: First, a 16 in. Victoria-Turbo Boving pump with maximum capacity 140,000 gallons per hour at 1,450 revolutions, direct coupled to a 175 b.h.p. Siemens 2,000 volt motor with liquid regulator; second, a 15 in. Worthington pump with maximum capacity 200,000 gallons per hour at 960 revolutions coupled to a 260 b.h.p. Crompton 2,000 volt motor.

Power is obtained from Pengkalen, Ltd., 50 cycle, 3 phase, alternating current being supplied at 2,000 volts; the average daily consumption is about 5,000 units. The 220 k.w. Diesel generator is retained as a stand-by. The transmission line is protected at each end by lightning arresters, those at Lahat being of the Siemens relay horn type.

The tailing is elevated by an 8 in. Thompson gravel pump to a height of 45 ft. The pump, which takes about 70 b.h.p., is belt-driven through a countershaft by a 125 b.h.p. Siemens 2,000 volt motor having a liquid starter and regulator. Careful tests show that this pump will lift 350 cubic feet of water per minute and 45 cubic yards of solid per hour with an overall mechanical efficiency of 38%. Seepage pumped from the mine is the only water available for the mill, and at times the quantity is only 100 cubic feet per minute. By a system of dams the tailing from the mine is completely settled and the water is returned clean to the mill pumps. By this means it is always possible to keep 350 cubic feet of water in circulation.

Hydraulic Stripping at Rooiberg.—At the November meeting of the South African Institution of Engineers, Edward R. Schoch read a paper entitled "Hydraulic Prospecting at the Rooiberg Tin Mines." The tin veins at Rooiberg are numerous, but as the ground is covered with sand or other material their outcrops are difficult to find. The sand contains cassiterite and is presumably the eluvial formed in situ by the disintegration of the rocks. The usual way of prospecting for the vein outcrops was to dig a series of trenches, but as this method is tedious, and also seeing that the surface sand contains tin, Mr. Schoch decided to adopt the system of hydraulic stripping and to pass the material thus removed through sluice-boxes. By this means he prospected for outcrops and won tin from the overlying sand at the same time. Hydraulic stripping has been done before, for example at Cobalt, but this is probably the first case of the hydraulic jet doing the double duty. The conditions at Rooiberg were not particularly favourable for the scheme, because water is scarce, the ground is flat, and the tin is very fine. It was necessary first to construct a dam to store water. We give herewith Mr. Schoch's account of the method as now at work.

The sand overburden is broken and washed down by means of a monitor and auxiliary water jets into a screened sump, from which the pulp is elevated by a gravel pump to a sluice-box about 20 ft. above the level of the ground. Where the ground has an insufficient fall for the pulp to gravitate, the sand overburden is removed in trucks and dumped into the sump direct. The sandy gravel in the sluice-box is turned over by natives with forks. From the sluice-box the tailing runs into concrete settling pits, where the water is drawn off into a return-water dam to be used again, while the tailing is discharged from the pits into trucks and trammed to the dump.

After the sluice-box has been filled with sand and gravel, which is effected by putting in stops or riffles from time to time, the material is run down with clear water, in order to reduce the bulk of sands and to intensify the concentration. This operation occupies about nine hours for a full sluice-box, the sand concentrate then containing anything up to 1% metallic tin. The concentrate is then removed, screened, and conveyed in a water-borne strip to a Wilfley table, which yields a concentrate of about 30% grade. Subsequent dressing of this material in the main plant at the mine brings the grade up to a marketable product of approximately 67% metallic tin. The concentrate recovered from this source is impure, containing other minerals, such as ilmenite, magnetite, garnets, tourmaline, zircon, and sometimes a little fine gold.

After the rocks have been denuded, they are carefully examined for the existence of lodes or fissures, and when such are found they are marked down for future exploration. Sometimes the presence of nodules and crystals of cassiterite indicates the vicinity of a fissure.

The most suitable gradient for the sluice-box was found to be 3%, and the material delivered to the boxes is about 2 lb. of solids to one gallon of water. The following is a grading analysis of an average tin concentrate after the material from the sluice-box has been treated on the Wilfley table:

Standard Mesh	Quantity	Met. Tin.
	"	%
+12	0·5	20·7
+20	1·5	57·5
+50	13·2	61·9
+80	27·8	29·9
+200	48·3	16·5
−200	8·7	22·5
	100·00	27·50

The capacity of the plant, which, as explained, is an experimental one, is about 100 cubic yards per day, but the yardage also depends on the amount of time devoted to the dressing and running down of the product in the sluice-box, and to the grade of the concentrate aimed at. The grade of the sand overburden before treatment varies from one to four pounds of tin per cubic yard, and the recovery to date in the above plant is about 1 lb. of metallic tin per cubic yard. The comparatively low extraction is mainly due to the fine state of the cassiterite in the gravel, and to the lack of proper classification, which is an essential for a high recovery even in a sluice-box. It has recently been decided to augment the plant by the addition of a Deister rougher, whereby the quantity of overburden treated will be considerably increased and an improved recovery of cassiterite obtained at a very small cost.

In concluding, Mr. Schoch said that the main object of installing the plant was to show that by sluicing the overburden sufficient cassiterite could be won therefrom to pay for the work, thus rendering this form of effective surface exploration both inexpensive and thorough. In this respect the installation proved a complete success.

SHORT NOTICES

Electric Winding.—The *Colliery Guardian* for January 10 contains the first of a series of articles containing simple calculations for the design of electric winding engines for mines.

Pumps.—At the meeting of the Institution of Civil Engineers held on January 28, R. C. Parsons read a paper on centrifugal pumps for dealing with liquids containing solid, fibrous, or erosive substances.

Mining Methods at U.V.X.—The January *Bulletin* of the American Institute of Mining Engineers contains a paper by C. A. Mitke describing the method of mining the big ore-body at the United Verde Extension copper mine, Jerome, Arizona.

Rock-Drills.— At the December meeting of the South African Institution of Engineers, H. S. Potter read a paper on modern rock-drills.

Malayan Tin Dredging.—In the Australian *Statesman and Mining Standard* for October 3, E. T. Miles commences a series of articles giving particulars of the Australian participation in tin-dredging operations in Siam and the Malay Peninsula

Flotation.—In *Chemical and Metallurgical Engineering* for December 15, Guy C. Riddell discusses Leslie Bradford's selective method of treating lead-zinc slime as employed at the Broken Hill Proprietary

Movement of Gold in Copper.—In a paper appearing in the January *Bulletin* of the American Institute of Mining Engineers, Edward Keller shows that when auriferous copper sheet is exposed to oxidation the gold may be redistributed irregularly in the surface layer

Copper Leaching.—The *Engineering and Mining Journal* for December 21 publishes a paper by Louis F. Clark giving methods of estimating free acid in solutions containing metallic salts, the methods being particularly applicable in the leaching of copper ores

Aluminium.—*Chemical and Metallurgical Engineering* for December 15 publishes a translation, with many illustrations, of a lengthy paper by O. Nissen which appeared in *Teknisk Tidskrift* for August, 1917.

Aluminium.—The *Journal* of the Society of Chemical Industry for December 31 publishes a paper by J. J. Fox, E. W. Skelton, and F. R. Ennos on the analysis of aluminium and its alloys.

Oil Production.—At the December meeting of the Institution of Petroleum Technologists, Dr. F. Mollwo Perkin read a paper on the production of oil by the carbonization of coal.

Paraffin Wax.—At the January meeting of the Institution of Petroleum Technologists, A. Campbell and W. J. Wilson read a paper on the manufacture of paraffin wax from petroleum.

Hydrogen.—*Engineering* for January 24 contains an illustrated article describing the plant used by the Admiralty for generating hydrogen to be used in filling balloons and airships. The plant is made by the Société l' Oxylithe, and the process is that of Jaubert. The hydrogen is generated by treating "silicol" with a strong solution of caustic soda. Silicol is a product of the electric furnace and may be either ferro-silicon, mangano-silicon, or silico-spiegel. It is cheaper to use than pure silicon.

Petrography of Sedimentary Rocks.—At the meeting of the Midland Institute of Mining, Civil, and Mechanical Engineers held on January 30, Dr. A. Gilligan read a paper on the petrography of sedimentary rocks with special reference to the Coal Measures.

Kent Coal.—In the *Iron & Coal Trades Review* for January 10, A. E. Ritchie commences a series of articles on the history and development of the Kent coalfield.

Wallaroo & Moonta.—In *Chemical Engineering & Mining Review* for October, H. Lipson Hancock gives particulars of the welfare work at the properties of the Wallaroo & Moonta copper mining company, in South Australia.

RECENT PATENTS PUBLISHED.

13,131 of 1917 (121,203). E. EDSER, S. TUCKER, and MINERALS SEPARATION, LTD., London. The use of an alkaline silicate for obtaining a preferential separation of mixed sulphides.

15,581 of 1917 (121,617). J. T. I. CRAIG and PETER SPENCE & SONS, LTD., Manchester. Manufacture of chromium and iron compounds used in dyeing.

17,973 of 1917 (112,019). MINERALS SEPARATION, LTD., London. Improvements in the cascade method of flotation, devised for the purpose of maintaining constant the levels of the pulp in each successive box.

18,744 of 1917 (121,512). R. W. PLEASANCE, London. An improved system of screens suitable for alluvial gold-mining or coal washing operations.

7,650 of 1918 (115,639). G. GRÖNDAL, Djursholm, Sweden. In roasting furnaces, making the rotating arch, which carries some of the rabbles, movable upward as well as forward and backward, and sealing the sides from entry of air by a sand or water seal.

8,829 of 1918 (121,253). A. R. MACKIE, Lander, Wyoming. Improved apparatus for sluice-boxes for recovering gold from alluvium.

NEW BOOKS

Geology of Hororo District, Papua. This is Bulletin No. 4 of the Territory of Papua, and contains a report by W. G. Langford on the geology of the Hororo district, in the Papuan oilfield.

Geology of the Country around Gatooma. This is Bulletin No. 5 of the Geological Survey of Rhodesia, and is written by A. E. V. Zealley and B. Lightfoot. The chief mine in this district is the Motor, operated by the Cam & Motor company.

Rock Quarrying for Cement Manufacture. By Oliver Bowles. Bulletin No. 160 of the United States Bureau of Mines.

Melting Brass in a Rocking Electric Furnace. By H. W. Gillett and A. E. Rhoads. Bulletin 171 of the United States Bureau of Mines.

The Manufacture of Aluminium. By J. T. Pattison. Cloth, small octavo, 104 pages, illustrated. Price 7s. 6d. net. London: E. & F. N. Spon, Ltd.

The author of this little book was recently in charge of the chemical laboratory of the Aluminium Corporation at Wallsend-on-Tyne. About 60% of the book is devoted to his special branch of the subject, the analysis and examination of ores, raw material, electrodes, the metal and its alloys, etc.

General Metallurgy and the Metallurgy of Iron. By Professor Umberto Savoia. Paper covers, octavo, 530 pages, illustrated. Price 28 lira. Milan: Ulrico Hoepli.

This book gives an outline, or summary, of the principles of metallurgy, with special reference to the metallurgy of iron and steel. It is not an advanced textbook, but is easily read by anyone of average education. Hitherto the Italian iron and steel people have depended chiefly on French literature. The publication of this book should prove helpful in Italy where the iron industry is expanding.

Cast Iron, in the Light of Recent Research. By. W. H. Hatfield. Second Edition. Cloth, octavo, 300 pages, illustrated Price 12s. 6d. net. London: Charles Griffin & Co. Ld.

Dr Hatfield is one of the group of brilliant metallurgists who conduct research at Sheffield. The chapters in this book deal with cast iron from the point of view of the equilibrium diagram, the influence of silicon, phosphorus, sulphur, manganese, etc., heat treatment, the casting temperatures, mechanical properties, the properties of malleable cast iron, the growth of cast iron after repeated reheating, and many other subjects. The most important part of the additional matter contained in the new edition relates to malleable cast iron, a branch of the subject which has attained much prominence during the war.

COMPANY REPORTS

Pahang Consolidated.—This company was formed in 1887 as the Pahang Corporation to acquire tin lode deposits in the state of Pahang, Federated Malay States. In 1906 the Pahang-Kabang and Malayan Exploration companies were absorbed, the name changed, and additional capital subscribed. In 1909 the scale of operations was expanded on the advice of William Frecheville, and further funds provided. The results obtained since then have been excellent. The report for the year ended July 31 last shows that 187,300 tons of ore was mined and milled for a yield of 1,993 tons of tin concentrate, and that 121 tons of concentrate was obtained from alluvial workings, making a total of 2,114 tons. During the previous year 156,700 tons yielded 2,657 tons of concentrate, and 115 tons of alluvial tin was won, making a total of 2,772 tons. The fall in the grade of the ore treated is due to more of the soft low-grade ore being mined by open-cut, the opportunity being taken of mining this ore during a period of high prices for the metal. The development has been confined to lateral exploration recently, owing to the impossibility of working below the 800 ft. level until new pumps can be obtained capable of combating the water. J. T. Marriner, the manager, reports that the total reserves are about 600.000 tons. As regards the prospects, Willink's section is likely to continue to supply the largest proportion of ore. At the Gunong mine, No. 5 level has not been so productive as the levels above, but there is good reason to expect a continuance in depth. At Semeliang mine, a new ore shoot has been discovered, and it may be necessary to sink another shaft to work it. The accounts show an income from the sale of tin concentrate of £366,854, and a net profit of £139,167, out of which £56,206 has been distributed as dividend on the ordinary shares, at the rate of 20%, and £8,500 on the preference shares, at the rate of 15%.

Broken Hill Block 10.—The report for the half-year ended September 30 last shows that 28,319 tons of ore was raised, averaging 11·48% lead, 11·61% zinc, and 10 06 oz. silver per ton. This ore, together with 4,782 tons of Block 14 ore, was sent to the mill, making a total of 33,101 tons treated. The yield of lead concentrate was 5,416 tons averaging 62 3% lead, 7·4% zinc, and 40 7 oz silver, and the zinc tailing was 27,685 tons averaging 12 3% zinc, 1 9% lead, and 4 1 oz. silver. This tailing on treatment by flotation yielded 5,899 tons of zinc concentrate averaging 47 7% zinc, 5·7% lead, and 13·5 oz. silver. The accounts show a net profit of £20,211, out of which £12,500 has been distributed as dividend, being at the rate of 2s. 6d. per £10 share. The company also owns the Misima gold mines, in the island of Misima, off the east end of New Guinea. The plant there is being enlarged to treat 5,000 tons per month.

Broken Hill Block 14.—For some years past this company depended for its income on the carbonate ore in the old stopes in the upper levels, but in November, 1917, the mining of the sulphides was resumed. At first the sulphide ore was sent for treatment to the Junction North company's mill, and since June 20, 1918, it has been sent to the new treatment plant jointly owned by this company and Block 10 company. The report for the half-year ended September 30 last shows that 4,061 tons of carbonate ore, averaging 22 55% lead and 13 67 oz. silver per ton, was raised and delivered to the Associated Smelters at Port Pirie. In addition 13,220 tons of sulphide ore was raised. Of this, 5,849 tons, averaging 14·12% lead, 9 88% zinc, and 10·31 oz. silver, was delivered to Junction North; 7,371 tons, averaging 13 62% lead, 11 08% zinc, and 10·1 oz. silver, was delivered to the joint plant; while 2,589 tons was stacked, owing to temporary coal-shortage at the mill. The present deliveries to the joint plant are at the rate of 600 tons per week. The accounts show a working profit of £5,143. The company also has a large interest in the King Island Scheelite Co., and received during the half-year a dividend of £2,057 from this investment. After allowing for income-tax and depreciation, and crediting a profit on the sale of King Island shares, the net profit for the half-year was £8,009, out of which £6,500 has been distributed as dividend.

Mount Read & Rosebery Mines. — This company was formed in 1916 by the Mount Lyell company to purchase zinc-lead-silver-gold mines from the Hercules, Primrose, and Tasmanian Copper companies, situated on the west coast of Tasmania, about 16 miles from Mount Lyell. It is intended to treat the ore by the electrolytic zinc process, and bulk samples were tested at Anaconda with satisfactory results. The report for the year ended September last contains a record of the work done at the mines and in connection with metallurgy and hydro-electric plant. As this is an important new venture, we quote the report in some detail.

At the Hercules mine, the main adit, at the new No. 5A level between Nos. 4 and 5 levels, was started and driven 427 ft. in a south-easterly direction. It passed entirely through country rock, and is now nearing the ore body. The new main adit at the No. 5 level was commenced from a position at the surface convenient to the haulage line and 580 ft. distant from it. It has been extended 429 ft. in a south-easterly direction through country rock. This drive should also reach the ore-body at an early date. The 620 ft. north drive from the old main adit at the No. 5 level was extended 237 ft. (total 274 ft.) during the year. The "E" ore-body was met at 75 ft. and continued to the end of the drive. The assay-values were as follows:

From	To	Zinc	Lead	Silver.	Gold.
		[illegible]	%	oz	oz.
75 ft	105 ft	[illegible]	2 9	4 1	0 03
105 ,,	167 ,,	[illegible]	0 6	0 7	0 03
167 ,,	188 ,,	[illegible]	1 4	1 8	0 05
188 ,,	226 ,,	[illegible]	16·1	13·1	0 29
226 ,,	274 ,,	46 1	11·3	13·5	0·17

These results confirm the information previously obtained from diamond-drilling.

At the Rosebery mine, a large amount of development work and some exploration by means of the diamond-drill were carried out. The work done has been attended by satisfactory results, the diamond-drilling (1,897 ft.) indicating further accessions in the northern end of the mine and some in the southern end (Primrose lease). At the No. 3 level the north drive was extended 233 ft. (total 353 ft). This drive is being put out on a north-westerly course to reach the lode, which was proved by diamond-drilling to be very strong at this horizon.

At the No. 4 level the north drive was extended 276 ft. (total 833 ft.) on a north westerly course, keeping in the lode over the whole distance. The following assays were found :

From	To	Zinc.	Lead.	Silver.	Gold.
		%	%	oz.	oz
559 ft	639 ft	25·7	7·7	14·4	[illegible]·13
659 ,,	729 ,,	30·8	10·7	15·6	[illegible]
765 ,,	8[illegible]0 ,,	25·4	2·7	7·5	0·12

At the No. 5 level the north drive was started and driven 216 ft. north-westerly along the lode. The results are very satisfactory, the following assays being disclosed :

From	To	Zinc.	Lead.	Silver.	Gold
		%	%	oz	oz
0 ft	48 ft.	29·8	6·4	9·1	0·16
48 ,,	70 ,,	18·8	4·6	5·91	0·11
70 ,,	149 ,,	30·0	5·8	8·85	0·11
149 ,,	216 ,,	22·3	7·3	8·4	0·14

At the No. 6 level the north drive was extended 185 ft (total 776 ft.), the ore passed through assaying as follows :

From	To	Zinc.	Lead	Silver	Gold
		%	%	oz	oz
530 ft.	648 ft.	23·0	5·9	8·2	0·10
648 ,,	6[illegible]5 ,,	10·2	2·7	4·3	0·10
702 ,,	776 ,,	30·9	11·9	15·7	0·23

Three cross-cuts proved the lode to be from 10 to 20ft wide.

At the main adit level the north drive was extended 287 ft. (total 503 ft.) Assays were as follows :

From	To	Zinc.	Lead.	Silver.	Gold.
		%	%	oz.	oz.
216 ft.	258 ft.	22·5	4·8	5·4	0·12
258 ,,	394 ,,	14·8	4·0	5·6	0·10
394 ,,	431 ,,	24·4	5·9	7·7	0·20
431 ,,	503 ,,	15·8	4·2	5·9	0·10

The general manager, R. C. Sticht, returned from the United States at the end of January. In a report dealing with the results of his observations and investigations of the electrolytic treatment process, as currently practised in America, he recommends the adoption of this method, subject to the application of electric power at a reasonably low cost. The parcel of ore sent to America (110 tons) was bought by the Anaconda company, and treated at their Great Falls electrolytic zinc plant, payment being made for the zinc, lead, silver, and gold contents. Laboratory research is being conducted at Queenstown, with the object of determining the nature of the ores in question. It is proposed, as soon as possible, to install an experimental plant under working-scale conditions, with a daily capacity of about one ton of metallic zinc. This will be sufficient to supply the working data necessary for guidance in connection with the larger plant. The erection of the latter is dependent upon the satisfactory settlement of the power-supply question. In view of the circumstance that it will be some time before hydro-electric power will be available for electrolytic treatment on a profitable commercial scale, it has been decided to proceed with the immediate erection of an oil-flotation plant, of an initial capacity of about 200 tons of ore per day. Such a plant will, in any case, be required in the future for the preparation of the lower-grade ores for the electrolytic treatment. The object of the plant will be to fully work out the special concentration problems presented by these ores, and also to derive the profit from the sale of their metallic products which is indicated by the commercial conditions of the day.

During the year, the Tasmanian Government Hydro-Electric Department has undertaken the carrying out of a considerable amount of work in connection with the King River Power Scheme, and, in view of the local circumstances, it arranged with the Mount Lyell Mining & Railway Company, Ltd., to do the work on its behalf. Early in November of 1917 work was commenced on a diversion cut in the rocky bank of the King River at the dam-site. This channel has a length of 250 ft., with a bottom width of 12 ft., and contained approximately 2,000 cubic yards of rock excavation. It was completed early in April last, and the river flow diverted through it by means of a temporary log and lath weir near the inlet, leaving the original bed of the river free of access for examination. The seat of wall on each bank has been stripped of scrub and debris, and the solid rock exposed over the whole length of the wall. The results of these operations have established the suitability of the site for a large curved wall, such as is proposed. Very extensive survey operations have also been carried out. Two survey parties were engaged during the summer locating the submerged areas at each of the 750, 720, and 690 contours The total traverses run, with levels and cross sections, equal 61 miles ; and these give a total shore line, at the 750 level, of 70 miles, with an area of 13 square miles. In addition, the contour survey of the wall site was extended, and a survey was also made of a wall site in the King gorge near the Dubbilbarril railway station. Here a scheme can be formulated to utilize the tail water from the upper scheme with a head of at least 150 ft. A trial survey for a 3 ft. 6 in. gauge railway from the old Crotty smelters to the wall site has also been run, giving a total length of 2¾ miles. Quantities for this work are now being prepared. Preliminary designs and quantities for various types of concrete dam walls, suitable for the proposed site and for other portions of the scheme, have been prepared with the Mount Lyell company's officers, and are in such a state that work can be commenced without delay. During the period, about seven miles of the timbered portion of the transmission line to Zeehan, between the Lake Margaret power station and Zeehan, were felled for a width of 66 ft., and burnt off during last summer.

Mount Lyell Mining & Railway.—The report for the year ended September 30 last shows that shortage of labour and reduced working hours continue to restrict the output. At the Mount Lyell mine 153,281 tons was mined and sent to the smelters, averaging 0·43% copper, 1·3 oz. silver, and 0·8 dwt. gold, and in addition 3,286 tons was sent to the acid works. At the North Lyell mine 92,368 tons was raised, of which 78,561 tons averaging 6·77%, 1·67 oz. silver, and 0·16 dwt. gold was sent to the smelters, and 13,807 tons averaging 3·26% copper, 0·46 oz. silver, and 0·18 dwt. gold was sent to the flotation plant. The flotation plant treated 29,703 tons of ore averaging 2·95% copper, of which 15,639 tons came from the Lyell Comstock, 13,935 tons from the North Lyell, and 129 tons other sources, and it produced 7,348 tons of concentrate averaging 10·5% copper, 0·91 oz. silver, and 1·4 dwt. gold. The smelters treated 153,990 tons of Mount Lyell ore, 78,999 tons of North Lyell ore, 6,589 tons of concentrate, and 1,369 tons of purchased ore. The output of blister copper was 5,773 tons, containing 5,705 tons of copper, 320,344 oz. of silver, and 7,042 oz. of gold. The cost of producing blister copper per ton of ore was 27s 1d , as compared with 26s. 6d the year before, and 23s. 6d. two years ago. Developments by mining and drilling have disclosed further supplies of ore. The estimate of ore reserves at September 30 was : Mount Lyell, 2,028,747 tons averaging 0·49% copper, 1·48 oz. silver, and 0·8 dwt. gold ; North Lyell, 1,036,300 tons averaging 6% copper, 1·33 oz. silver, and 0·1 dwt. gold. These figures are slightly higher than those a year ago, and they take no account of ore disclosed by recent diamond-drill bores. The acid and superphosphate works at Yarraville, near Melbourne, were operated on a reduced scale owing to the lack of demand for fertilizers in Victoria and the difficulty of making shipments to New Zealand. The works at Fremantle were closed for a few months on account of decreased consumption, but they are now in operation again. The raising of the dam at Lake Margaret is being proceeded with. It has already been raised 8 ft., and is to be raised 22 ft. altogether. The catchment of Lake Peter has been connected with Lake Margaret by a short channel, and the available water is increased thereby by 12%. The foundations for the third steel pipe and connections are ready, as also are those for the fifth and sixth turbines and generators. The accounts show an income of £916 086, and a net profit of £247,228, out of which £209,494 was distributed as dividend, being at the rate of 3s. 3d. per £1 share.

Knights Deep.—This company was formed in 1895 to acquire property on the dip of the Glencairn and Knights in the middle east Rand. The control is with the Consolidated Gold Fields. In 1913 an amalgamation was effected with the Simmer Deep. The report for the year ended July 31, 1918, shows that 1,140,700 tons was raised and sent to the mill without sorting, and that 201,495 oz. of gold worth £842,442 was extracted. The working cost was £821,423, and the working profit £21,019. The yield and cost per ton were 14s 9d. and 14s. 4d. respectively. The cost per ton was 1s. 1d. higher than the year before, and the working profit £72,195 less. The ore reserve is calculated at 1,671,000 tons averaging 4·43 dwt. Large blocks of ground have been eliminated from the estimate owing to the margin of profit having disappeared with the increase of cost. Caving has also prevented some of the developed ore from being mined.

Simmer & Jack.—This company belongs to the Consolidated Gold Fields group, and was formed in 1887 to acquire property on the outcrop to the east of the central Rand. The mine has always been one of comparatively low grade. The report for the year ended June 30, 1918, shows that 721,897 tons of ore was raised and, after sorting, 685,400 tons was sent to the stamps. The output of gold by amalgamation and cyaniding was worth £791,892, or 23s. 1d. per ton, and the working cost was £596,588 or 17s. 5d. per ton, leaving a working profit of £195,303, or 5s. 8d. per ton. Taxes, phthisis contribution, etc., absorbed £39,662, and £112,500 was distributed as dividend, being at the rate of 3¾%. The ore reserve is estimated at 1,538,000 tons averaging 5·67 dwt. per ton, and 211,000 tons of partly developed ore have an indicated content of 4·98 dwt. There is much ore that can be reclaimed from the upper levels. Little ground remains to be developed. During the year under review, jackhammers have been extensively employed, to make up for the deficiency in native labour supply.

Sub-Nigel.—This company was formed in 1895 to acquire property on the dip of the Nigel gold mine in the Heidelberg district, on the southern side of the Far East Rand basin. In 1909 the adjoining property of the Nigel Deep was absorbed. The control is with the Consolidated Gold Fields. The report for the year ended June 30 last shows that 193,294 tons was mined, of which 45,588 tons was shaft and development waste. After the removal of a further 20% of waste at the sorting station, 115,780 tons of ore was sent to the mill. The yield by amalgamation and cyaniding was 68,115 oz. worth £284,001, being 11·76 dwt. or 49s. per ton milled. The working cost was £192,231, or 33s. 2d. per ton, leaving a working profit of £91,769, or 15s. 10d. per ton. Taxes, etc., absorbed £18,832, and £77,291 was distributed as dividend. The yield per ton was 5s. higher than during the previous year. During the year 43,420 shares were issued in payment for additional property, and 300,000 shares were issued at par for cash to provide for a new vertical shaft and extensive development. Property on the dip in the Grootfontein has also been acquired, but the payment in shares is not to be made until 1921. During the year under review £53,473 has been spent on capital account, mostly in connection with the new shaft, but also on metallurgical plant. The reserve is estimated at 387,000 tons averaging 10·3 dwt

Witbank Colliery.—This company was formed in 1896 to acquire coal deposits in the Middelburg district of the Transvaal, about 90 miles east of Johannesburg. The control used to be with Neumann's, and passed to the Central Mining & Investment Corporation in July, 1917. The sale of coal commenced in 1898, and increased gradually until 1909, since when the yearly output has been fairly regular. The report for the year ended August 31, 1918, shows that at the Witbank mine 513,658 tons was raised, and at the Uitspan 394,080 tons, making a total of 907,738 tons. Of the total, 117,614 tons was fine and dust, which went to the dumps. The accounts show a net profit of £90 234, out of which £57,750 has been distributed as dividend, being at the rate of 27½%.

Clydesdale (Transvaal) Collieries.—This company is a subsidiary of the South African & General Investment & Trust Co., and was formed in 1895 under Transvaal laws to acquire the north-western corner of Daggafontein farm in the Far East Rand. The northern half of the property was leased, and afterwards sold, to the Cassel Colliery Co. In 1904 the property of the Pioneer Coal Syndicate, in the Heilbron district, Orange Free State, was purchased, and in 1914 the coal rights of a portion of the Blaauwkrants farm in the Middelburg district of the Transvaal were acquired. The colliery on Daggafontein was exhausted in 1916. The report for the year ended June 30, 1918, shows that at the Coalbrook mine at Heilbron the output was 203,990 tons, and at the Clydesdale colliery in the Middelburg district 206,630 tons. The net profit for the year was £26,976, out of which £13,875 has been distributed as dividend, being at the rate of 7½%. The gold-mining rights of the original Daggafontein property are being amalgamated with those of the Cassel Co., and a company is to be formed to work them, financed by Sir Abe Bailey.

East Rand Gold, Coal, & Estate.—This company was formed in 1895 to acquire the freehold farm Vischkuil in the Far East Rand. Bore-holes put down in 1896 indicated the existence of a gold-bearing reef, but no shaft-sinking has been done. A colliery is being worked, which yielded distributable profits from 1910 to 1914. The coal is, however, of low grade, and the demand is not equal to the allotment. The report for the year ended June 30, 1918, shows that 95,123 tons was raised and sold. The allotment fixed by the Transvaal Coal Owners' Association was 120,000 tons. The net profit for the year was £1,732.

CHAMPION REEF GOLD MINING CO. OF INDIA, LTD.

Directors: John Taylor (*Chairman*), Lord Ribblesdale (*Vice-Chairman*), Lord Glenconner, Sir John F. F. Horner, Sir J. D. Rees, Edgar Taylor. *Managers:* John Taylor & Sons. *Secretary:* F. H. Williams. *Office:* 6, Queen Street Place, London, E.C. 4. *Formed* 1889. *Capital:* £260,000 in shares of 2s. 6d. each.

Business: Operates a gold mine in the Kolar District, Mysore State, South India.

The adjourned thirtieth ordinary general meeting of the Champion Reef Gold Mining Company of India, Ltd., was held on January 15 at the Cannon Street Hotel, London, E.C., Mr. John Taylor (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended September 30, 1918, said that the meeting had been adjourned from December because the accounts had not been received from India in time for the meeting to be held at the ordinary time. The total production of gold for the 12 months amounted to 94,238 oz. Of this total, 76,836 oz. came from 138,030 tons of rock crushed in the mill and 17,403 oz. from the cyanide works, where 205,320 tons of tailing was treated. This latter quantity included 67,290 tons of accumulated sand and slime, as well as the whole of the tailing from the ore milled. The tube-mill and classification plant ran satisfactorily throughout the year, and a more finely ground product was obtained, resulting in an improved extraction. Compared with the previous twelve months, the average value of the ore milled was over 10½ grains lower, but the net yield was only 7 grains lower, showing an improvement in the extraction of over 3½ grains to the ton. The revenue derived from the sale of gold amounted to £399,505 and from interest, rents, and other receipts £7,755. Royalty to the Mysore Government amounted to £21,848, and the costs totalled £285,450. In the previous year the costs amounted to £267,136, and an increase was thus shown of £18,314, notwithstanding the lesser quantity of rock milled of 11,582 tons. The rise in cost was attributable in a very large measure to adverse conditions arising out of the war. The balance of the income and expenditure account was £99,952, representing the profit for the year under consideration. With the addition of the balance brought forward and the dividend on the Kolar Mines power station, a total of £105,877 was shown at the credit of profit and loss account. This was disposed of as follows: Income tax, £25,289; depreciation, £6,000; prospecting department, £748; interim dividend of 4d. per share and the percentage thereon, paid in July last, £35,360. It was now proposed to pay a balance dividend of like amount, leaving £3,812 to be carried forward. The total amount distributed for the year would then be £69,333, equal to 8d. per share, or 26⅔%. This was of course, not to be compared with the best records of the company, but was distinctly better than the results of the leanest years some ten years ago. The mine was not yet showing the improvement which they so much wished to see, but, in view of recent developments, the fact that their ore reserves had not diminished by more than 15,306 tons, and amounted to 335,949 tons, might be looked upon as very satisfactory. With regard to the immediate future, the returns for the first three months of the company's financial year amounted to 20,970 oz., a decrease of 2,617 oz. as compared with the corresponding months of the previous year, and the present aspect of the developments pointed to a continuance of the lower scale of returns until the mine took a more favourable turn.

Lord Glenconner seconded the resolution

Mr. Edgar Taylor then gave particulars of the mining operations. He said that during the year 9,079 ft. of underground development work had been accomplished. This included 913 ft. of sinking at Garland's, Glen, and Carmichael's shafts. Carmichael's shaft, the deepest point, had now reached the 59th level, which was just about 5,500 ft. vertically below surface. The cross-cut west from the shaft had intersected reef 1½ ft. wide, assaying 6 dwt. per ton, and the level south had been started and driven a few feet on this. The 55th level south was continued in exploration of the new ore-body mentioned last year as lying about midway between Carmichael's and Glen shafts. Ore was discovered here during the year, and a length of 150 ft. was opened up on reef 2½ ft. wide, assaying 14 dwt. The 53rd level south from Carmichael's was also continued, and the same ore-body was driven through a distance of 158 ft., averaging at this level 1¾ ft., assaying 1 oz. 7 dwt. From the 51st level, where it was first discovered, down to the 55th, a depth of about 400 ft., the superintendent remarked that this shoot made a very useful addition to the ore reserves. Unfortunately, below this for the last 400 ft. of sinking in this section no profitable ore ground had been developed at the 57th and 59th levels, so far as explored, only low-grade having been found. At Glen shaft, at the time of the last annual meeting, another good shoot of ore had been explored down to the 54th level. This had averaged about 250 ft. in length. The 55th level was started during the past year, and was advanced 353 ft. in ore. At this new level there had been some signs of deterioration in value, the cross-course having disturbed the lode and for a considerable distance rendered the drivage unproductive. Beneath this point some improvement had occurred, as in a winze below the 55th level quartz had been discovered of a value of 2 oz. over a width of 3 ft., and at the 56th level north the shoot appeared to have been entered, as the lode had a width of 1 ft., assaying 1 oz. per ton. In Garland's section, on the new ore body dipping in from the south, although the lode had regularly carried a good width of quartz it had as yet proved of too low a grade to be brought into the reserves, and further exploration here would be looked to with great interest. The 53rd level south from Glen shaft was being driven under these workings. Here they had reef 3½ ft. wide assaying 4 dwt. and it was obvious that any further improvement here would have a most important bearing on the future of the mine. The ore reserves showed a decrease of 15,306 tons, and were estimated to amount to some 336,000 tons. At the mill, a good rate of extraction —namely, 97·6% of the assay-value of the ore—was obtained by the combined milling, tube-milling, classification and cyanide processes. In the engineering department one of the new and powerful underground hoists had been put into commission. The programme of work to be carried out during the current year was a vigorous one, and resulting from it they would hope to see the development of payable shoots of ore both in depth and by the lateral extension of the deeper levels, particularly in the southern part of the mine.

The motion was carried unanimously.

RHODESIA EXPLORATION COMPANY, LIMITED.

Directors: H. G. Latilla (*Chairman*), G R Bonnard, W W Clarke, R De La Bere, Sir Harry Foster, F. H Hamilton, R. Sewell. *Secretary:* W M Campbell *Office*: Finsbury Pavement House, London, E C 2. *Formed in* 1917 as a reconstruction of the Amalgamated Properties of Rhodesia, Ltd *Capital issued:* £415,452. 6s., in shares of 3s. each.

Business: The finance and development of mines and land in Rhodesia, the Transvaal, and Bechuanaland.

The adjourned first ordinary general meeting of the Rhodesia Exploration Company, Ltd., was held on January 28 at River Plate House, Finsbury Circus, London, E.C., Mr. H. G. Latilla (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, reviewed the position of the company. He said that as regards their assets, they owned over 1,100,000 acres in Rhodesia. The land, of course, varied in value, but, generally speaking, it had been well selected, and was in some of the best districts. He was not going to prophesy what the conditions in Rhodesia would be after peace. It was, however, pretty safe to prophesy that they would be a good deal better than they were during the war. The men who had been fighting were returning. There was already a tendency for land values to improve, and they had received during the last few months almost as many offers, firm and tentative, as they previously did in the same number of years. Their mining interests included a lawsuit against the Globe and Phœnix Company. They were instructed by the shareholders to carry the appeal to the House of Lords, and they had done so to the beat of their ability. The case was expected to be heard within a few days, and he would only tell them that they would not believe they had lost it until an adverse decision was actually given.

They had important interests in the Far East Rand, at Maraisdrift. A rough sketch map had been issued with the report showing the position of this property relatively to others in the same district. It had been compiled from the best data available, but they did not take responsibility for its exact accuracy, especially for the lines which indicated the course of the Van Ryn and Nigel reefs. That could not well be mapped out exactly, but they had taken it from existing maps, and they believed it to be as nearly correct as possible on the available evidence to date. He would advise shareholders to keep these maps, because they were likely to find them of great interest during the next twelve months. The Far East Rand was to-day the most interesting goldfield in the world. Two or three years ago it was only believed in by a handful of enthusiasts; to-day nearly every one of the great South African houses held interests in it. During the last few weeks fresh evidence of its value had been forthcoming. He did not want to excite anyone's optimism unduly, but there were two points to be kept in mind. One was that in Maraisdrift there was an element of practically assured value, as well as an element of speculation. They would see by the map that they were almost next door to the Sub-Nigel property. They could take it as nearly certain as anything of this kind could be that the reef which the Sub-Nigel was working—whatever its name might be—underlay a great part of Maraisdrift. That was the element of certainty. Then it was believed that the Van Ryn reef, which was enormously valuable, also ran through Maraisdrift. He would not go into the details of the evidence of this, but he would say that it was growing greater every day. That was the element of speculation he referred to, but he need not tell them that it opened up very great possibilities. The other point he wanted them to keep in mind was this: whenever they heard the Far East Rand spoken about they would realize that this company occupied a most important position, practically in the middle of it. As they knew, others held a one-third interest in Maraisdrift. Negotiations had been going on for a long time past with regard to that. He was glad to say they were now completed. The result was that they were assured of the entire co-operation of the owners of that interest. The same remark applied to the neighbouring block, Klippoortje, owned by the H. E. Proprietary Company. This was important for many reasons, particularly because Klippoortje was situated in the immediate dip of Tulip Vale, where exploratory workings had recently given very encouraging results.

Eighteen months ago, when the Court of Appeal gave judgment against them in the Globe and Phœnix action, they had to find over £80,000 to satisfy the costs of the other side, and certain other debts of the old company which the Globe and Phœnix had paid off. They applied for a stay of execution, but could not obtain it. That money had to be found, and found promptly, otherwise every one of their interests would have been sacrificed. He succeeded in obtaining the money, but, of course, one of the terms of obtaining it was that the company should be reconstructed. The terms were agreed; thousands of shareholders joined the scheme and gave definite instructions to prosecute the Globe and Phœnix appeal to the House of Lords. The board applied to the Treasury Committee for permission to make the new issue of shares, and they pointed out that the application was urgent. For eleven weeks they could obtain no definite reply whatever. They made the issue, not because they desired to defy the Committee, but because they had no option in the matter. The only alternative was that they should sacrifice the whole of the property and undertaking, and that, in duty to shareholders, they could not do. They did not doubt, however, that they would eventually obtain permission for the issue. They were not proposing to send a penny of money out of the country. The money was imperatively needed to pay their liabilities. Nevertheless, the Treasury Committee continued to refuse permission to this end, and had twice refused it since. One seldom got much satisfaction from an argument with officials, but he wanted to say one thing very emphatically. The Treasury Committee was a temporary and apparently uncontrolled administrative body. Its decision in this case meant, in effect, that 12,000 British shareholders were to be deprived of their right of appeal to the highest legal tribunal against what they believed to be an injustice. The board made the issue, but the effect of that refusal was that they could not obtain a settlement for the shares on the Stock Exchange.

Mr. G. R. Bonnard seconded the motion, and after Mr. F. H. Hamilton had given further particulars of the Maraisdrift property, the motion was put to the meeting and carried unanimously.

NEW MODDERFONTEIN GOLD MINING CO., LTD.

Directors: Sir E. A. Wallers (*Chairman*), H. C. Boyd, J. G. Currey, C. S. Goldman, S. C. Black, Major R. W. Fennell, W. T. Graham. *Secretaries:* Rand Mines Limited. *Head Office:* Corner House, Johannesburg. *London Office:* London Wall Buildings, E.C. 2. *Formed* 1888. *Capital:* £1,400,000 in shares of £4 each.

Business: Operates a gold mine in the Far East Rand.

The twenty-first ordinary general meeting of shareholders of the New Modderfontein Gold Mining Co., Ltd., was held in Johannesburg on December 19, 1918, Sir Evelyn Wallers, K.B.E., presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, 1918, said: You will have observed that, notwithstanding the many disabilities of the times, marked progress all round is shown, and shareholders are to be congratulated upon the results obtained. The year's working operations resulted in a profit of £833,264 from 684,100 tons milled, these figures showing increases of £48,247 and 27,400 tons over the corresponding results for the previous year. The profit averaged 24s. 4d. per ton milled, the yield being 45s. 7d. and working costs 21s. 3d. After delays, over which we had no control, the new reduction plant was completed in April of 1918, but as the drums for the new winder at the Circular Shaft had not then arrived, it was decided to commence milling operations on as large a scale as possible with the limited hoisting appliances which had up to that time served for the development of the Circular Shaft Section of the mine. In this way it was possible during the last three months of the financial year to add appreciably to the profits and at the same time to condition and test the efficiency of the new reduction plant. Looking at the figures for 1916 and comparing them with last year's, it will be seen that the yield has increased by 4s. 9d. and working costs by 4s. per ton as at June 30 last. The increase in costs calls for no particular remark, being common to all mines on these fields during the war period. The yield, however, was again higher than could be expected from the average value of our ore reserves. There are two reasons for this: the first is that on account of the constantly increasing working costs—caused mainly by prevailing conditions—it was considered expedient as well as legitimate, in view of the very strong ore reserve position, to continue the practice adopted last year of taking ore from the mine of somewhat higher value than the average value of the ore reserves, thereby counteracting the adverse circumstances and maintaining the level of profits; the second reason for the high yield is that—as was the case last year and the year before—the actual working results, particularly in the richest section of the mine, gave values considerably in excess of the block values as they appear in the ore reserve estimates. It may be noted that the second reason had a greater influence on the yield than the first, and it should be borne in mind also that shortage of native labour naturally necessitated a greater concentration of the force available than would otherwise have been the case. With an adequate supply the labour available would, of course, be more widely distributed in the mine, and mining operations would be conducted more in accord with the average value of the ore reserves. At all events it will be clear to you not only that we are in an enviable position in being able to combat disabilities by raising our grade at will, without straining our position in the least, but also that our ore reserve estimates have continued to be framed on very conservative lines. As bearing upon this latter feature, you will have noticed that the average grade of the ore developed during the year under review was lower than the grade mined, due mainly to the fact that practically no development was done in our richest areas; nevertheless it was possible to show a slight improvement in the average value of the ore reserves at the annual revision of the position at June 30 last. This requires a little explanation, that is, that although the rather abnormal richness of certain large blocks of grounds, particularly between the 8th and 10 levels east of No. 12 Shaft, has compelled our officials to be very cautious in their estimates, this section of the mine in particular has continued to yield ore of a value considerably above our legitimate expectations. We need not, however, complain about that.

A comparison with the previous year's figures will show that the development footage accomplished has fallen very considerably, being 27,117 ft. in 1917 and 13,661 ft. in 1918. On the face of it this appears to be a very serious decrease, and I will anticipate inquiry on this point by recalling the fact that in the previous year we took advantage of the then abundant supply of native labour to push development operations for the first six months of the year very energetically, particularly in the Circular Shaft Section, with the consequence that the development footage for that year was in reality abnormally high. The development footage for the year under review is little, if anything, below the footage required to maintain our ore reserve position. In fact, as you will see from the reports before you, the tonnage of payable ore developed during the last year amounted to 823,500 tons, while the tonnage mined from the ore reserves amounted to 658,723 tons. Our position therefore was more than maintained on that year's work; and even on the basis of crushing, say, 100,000 tons a month, which our plants are now capable of doing and the mine capable of producing, the mine is in such a condition that it would not require a very much larger development footage than that accomplished last year to replace all the ore taken from reserves. The point to bear in mind in this respect is that, given the necessary native labour, it is possible in our mine, by concentrating upon development work for even so short a period as, say, six months, to bring about the addition of very large tonnages to the reserves. Labour, as I have indicated, is the essential factor. Given a reasonably adequate supply there is not the slightest doubt that we can maintain our position with ease, and viewing our situation generally, I can only repeat the opinion I expressed last year, that we are indeed fortunate in possessing an extremely sound development and ore reserve position.

The ore reserve as at June 30, 1918, consisted of 9,000,000 tons of a value of 8.6 dwt. per per. This reserve can be seen from a reference to the map accompanying the annual report to be fully developed and conveniently situated to either of the reduction plants, the underground arrangements being very elastic. The following information relating to the claim property as at June 30 last may be of interest to you. The total claim area of the property is 1,301 claims, of which the barren area north of the outcrop amounts to 36½ claims and the wo ked out area at June 30 amounted to 241 claims, leaving approximately 1,024 claims. Of this balance approximately 289 claims are represented by the ore reserve. The accumulated unpayable area developed to date covers 96 claims, while the undeveloped area stands at approximately 639 claims. It is interesting and gratifying to note that the area equivalent to the ore reserve is greater than the total area worked out since the commencement of operations in 1895.

Turning now to the financial results for the year, the working profit, £833,264, after adding the income from interest, exchange, freehold and sundry revenue, and deducting amounts expended under the headings of Miners' Phthisis Compensation Fund and various donations, was increased to £850,878. Adding to this the unappropriated balance from the preceding year, namely, £354,906, and a small sum representing forfeited dividends, the funds at the company's disposal totalled £1,205,965. This was dealt with as follows: Two dividends of 15s. and 17s. 6d per £4 share absorbed £568,750; taxes, including adjustments for the preceding year, amounted to £110,706, and the net sum expended on capital account, after deducting £62,538 received under the Bewaarplaats Moneys Application Act, was £219,765. The unappropriated balance carried forward at £306,744 consisted of stores and materials valued at £154,297, cash £72,667—of which £19,000 is invested in British War Loans—and certain other items scheduled in the directors' report. The large sum expended on capital account was on account of the new reduction plant, underground equipment, a new native compound near the circular shaft, and additional quarters for married employees.

The new reduction plant, which consists of 56 Nissen stamps, 8 tube mills, and every requirement to deal with some 45,000 tons a month, has, as I informed you a year ago, cost a great deal more than originally estimated owing to circumstances beyond our control. While this fact is, of course, a matter for regret, yet the plant is paid for or provided for, and I feel sure that shareholders must view their situation to day with no small amount of satisfaction. Several years of very valuable time have been gained by following a bold policy, and we now possess reduction plants capable of dealing with 100,000 tons of ore per month, which quantity the mine is fully equipped to supply so long as sufficient native labour is available.

Since the close of the financial year, results have been achieved above anything hitherto shown in the past. By the end of September the erection of the new circular shaft winder had been completed, the change over took place in the first fortnight of October, and since that date the machine has been in operation and the whole equipment has given every satisfaction. For the first five months of the current year the tonnage milled averaged 72 600 tons a month, and the profit £90,285. or 24s. 10 5d. per ton milled. Working costs at 20s. 3 7d. are about 1s. per ton lower than for the past financial year, and will no doubt show a substantial further decrease as the tonnage output increases and general conditions become more normal. Until native labour becomes more plentiful we shall not be able to operate the two reduction plants to their full capacity, and while the shortage, due, as you are aware, to the influenza epidemic, continues, it is our intention to work the new plant to its full limit, that is, about 45,000 tons a month, leaving the spare capacity in the old plant. The object here is twofold – first, fully to test the possibilities of the new plant, and, second, to put the major portion of our tonnage through a more up-to-date and efficient plant; by this means we hope to secure lower reduction costs.

Mr. S C. Black seconded the motion, and it was carried unanimously.

NEW MODDERFONTEIN GOLD MINING CO., LTD.

Directors: Sir E. A. Wallers (*Chairman*), H. C. Boyd, J. G. Currey, C. S. Goldman, S. C. Black, Major R. W. Ffennell, W. T. Graham. *Secretaries:* Rand Mines, Limited. *Head Office:* Corner House, Johannesburg. *London Office:* London Wall Buildings, E.C. 2. *Formed* 1888. *Capital:* £1,400,000 in shares of £4 each.

Business: Operates a gold mine in the Far East Rand

The twenty-first ordinary general meeting of shareholders of the New Modderfontein Gold Mining Co., Ltd., was held in Johannesburg on December 19, 1918, Sir Evelyn Wallers, K.B.E., presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, 1918, said: You will have observed that, notwithstanding the many disabilities of the times, marked progress all round is shown, and shareholders are to be congratulated upon the results obtained. The year's working operations resulted in a profit of £833,264 from 684,100 tons milled, these figures showing increases of £48,247 and 27,400 tons over the corresponding results for the previous year. The profit averaged 24s. 4d. per ton milled, the yield being 45s. 7d. and working costs 21s 3d. After delays, over which we had no control, the new reduction plant was completed in April of 1918, but as the drums for the new winder at the Circular Shaft had not then arrived, it was decided to commence milling operations on as large a scale as possible with the limited hoisting appliances which had up to that time served for the development of the Circular Shaft Section of the mine. In this way it was possible during the last three months of the financial year to add appreciably to the profits and at the same time to condition and test the efficiency of the new reduction plant. Looking at the figures for 1916 and comparing them with last year's, it will be seen that the yield has increased by 4s. 9d. and working costs by 4s per ton as at June 30 last. The increase in costs calls for no particular remark, being common to all mines on these fields during the war period. The yield, however, was again higher than could be expected from the average value of our ore reserves. There are two reasons for this: the first is that on account of the constantly increasing working costs—caused mainly by prevailing conditions—it was considered expedient as well as legitimate, in view of the very strong ore reserve position, to continue the practice adopted last year of taking ore from the mine of somewhat higher value than the average value of the ore reserves, thereby counteracting the adverse circumstances and maintaining the level of profits; the second reason for the high yield is that—as was the case last year and the year before—the actual working results, particularly in the richest section of the mine, gave values considerably in excess of the block values as they appear in the ore reserve estimates. It may be noted that the second reason had a greater influence on the yield than the first, and it should be borne in mind also that shortage of native labour naturally necessitated a greater concentration of the force available than would otherwise have been the case. With an adequate supply the labour available would, of course, be more widely distributed in the mine, and mining operations would be conducted more in accord with the average value of the ore reserves. At all events it will be clear to you not only that we are in an enviable position in being able to combat disabilities by raising our grade at will, without straining our position in the least, but also that our ore reserve estimates have continued to be framed on very conservative lines. As bearing upon this latter feature, you will have noticed that the average grade of the ore developed during the year under review was lower than the grade mined, due mainly to the fact that practically no development was done in our richest areas; nevertheless it was possible to show a slight improvement in the average value of the ore reserves at the annual revision of the position at June 30 last. This requires a little explanation, that is, that although the rather abnormal richness of certain large blocks of grounds, particularly between the 8th and 10 levels east of No. 12 Shaft, has compelled our officials to be very cautious in their estimates, this section of the mine in particular has continued to yield ore of a value considerably above our legitimate expectations. We need not, however, complain about that.

A comparison with the previous year's figures will show that the development footage accomplished has fallen very considerably, being 27,117 ft. in 1917 and 13,661 ft. in 1918. On the face of it this appears to be a very serious decrease, and I will anticipate inquiry on this point by recalling the fact that in the previous year we took advantage of the then abundant supply of native labour to push development operations for the first six months of the year very energetically, particularly in the Circular Shaft Section, with the consequence that the development footage for that year was in reality abnormally high. The development footage for the year under review is little, if anything, below the footage required to maintain our ore reserve position. In fact, as you will see from the reports before you, the tonnage of payable ore developed during the last year amounted to 823,500 tons, while the tonnage mined from the ore reserves amounted to 658,723 tons. Our position therefore was more than maintained on that year's work; and even on the basis of crushing, say, 100,000 tons a month, which our plants are now capable of doing and the mine capable of producing, the mine is in such a condition that it would not require a very much larger development footage than that accomplished last year to replace all the ore taken from reserves. The point to bear in mind in this respect is that, given the necessary native labour, it is possible in our mine, by concentrating upon development work for even so short a period as, say, six months, to bring about the addition of very large tonnages to the reserves. Labour, as I have indicated, is the essential factor. Given a reasonably adequate supply there is not the slightest doubt that we can maintain our position with ease, and viewing our situation generally, I can only repeat the opinion I expressed last year, that we are indeed fortunate in possessing an extremely sound development and ore reserve position.

The ore reserve as at June 30, 1918, consisted of 9,000 000 tons of a value of 8 6 dwt. per per. This reserve can be seen from a reference to the map accompanying the annual report to be fully developed and conveniently situated to either of the reduction plants, the underground arrangements being very elastic. The following information relating to the claim property as at June 30 last may be of interest to you. The total claim area of the property is 1,301 claims, of which the barren area north of the outcrop amounts to 36½ claims and the worked out area at June 30 amounted to 241 claims, leaving approximately 1,024 claims. Of this balance approximately 289 claims are represented by the ore reserve. The accumulated unpayable area developed to date covers 96 claims, while the undeveloped area stands at approximately 639 claims. It is interesting and gratifying to note that the area equivalent to the ore reserve is greater than the total area worked out since the commencement of operations in 1895.

Turning now to the financial results for the year, the working profit, £833,264, after adding the income from interest, exchange, freehold and sundry revenue, and deducting amounts expended under the headings of Miners' Phthisis Compensation Fund and various donations, was increased to £850,878. Adding to this the unappropriated balance from the preceding year, namely, £354,906, and a small sum representing forfeited dividends, the funds at the company's disposal totalled £1,205,965. This was dealt with as follows: Two dividends of 15s. and 17s. 6d per £4 share absorbed £568,750; taxes, including adjustments for the preceding year, amounted to £110,706, and the net sum expended on capital account, after deducting £62,538 received under the Bewaarplaats Moneys Application Act, was £219,765 The unappropriated balance carried forward at £306,744 consisted of stores and materials valued at £154,297, cash £72,667—of which £19,000 is invested in British War Loans—and certain other items scheduled in the directors' report. The large sum expended on capital account was on account of the new reduction plant, underground equipment, a new native compound near the circular shaft, and additional quarters for married employees.

The new reduction plant, which consists of 56 Nissen stamps, 8 tube mills, and every requirement to deal with some 45,000 tons a month, has, as I informed you a year ago, cost a great deal more than originally estimated owing to circumstances beyond our control. While this fact is, of course, a matter for regret, yet the plant is paid for or provided for, and I feel sure that shareholders must view their situation to day with no small amount of satisfaction. Several years of very valuable time have been gained by following a bold policy, and we now possess reduction plants capable of dealing with 100,000 tons of ore per month, which quantity the mine is fully equipped to supply so long as sufficient native labour is available.

Since the close of the financial year, results have been achieved above anything hitherto shown in the past. By the end of September the erection of the new circular shaft winder had been completed, the change over took place in the first fortnight of October, and since that date the machine has been in operation and the whole equipment has given every satisfaction. For the first five months of the current year the tonnage milled averaged 72,600 tons a month, and the profit £90,285, or 24s. 10·5d. per ton milled. Working costs at 20s. 3·7d. are about 1s. per ton lower than for the past financial year, and will no doubt show a substantial further decrease as the tonnage output increases and general conditions become more normal. Until native labour becomes more plentiful we shall not be able to operate the two reduction plants to their full capacity, and while the shortage, due, as you are aware, to the influenza epidemic, continues, it is our intention to work the new plant to its full limit, that is, about 45,000 tons a month, leaving the spare capacity in the old plant. The object here is twofold – first, fully to test the possibilities of the new plant, and, second, to put the major portion of our tonnage through a more up-to-date and efficient plant; by this means we hope to secure lower reduction costs.

Mr. S. C. Black seconded the motion, and it was carried unanimously.

JOHANNESBURG CONSOLIDATED INVESTMENT CO., LTD.

Directors : S. B. Joel (*Permanent Chairman*), J. Emrys Evans, J. Friedlander, G. Imroth, J. B. Joel, Isaac Lewis, Sir R. B. Llewelyn, Charles Marx, John Munro, Sir J. S. Purcell, H. A. Rogers, A. R. Stephenson. *Secretary* W. H. Mardall. *Head Office :* Consolidated Building, Johannesburg. *London Office :* 10 & 11, Austin Friars, E.C.2. *Formed* 1889. *Capital issued :* £3,950,000.

Business : The finance and development of gold and diamond mines in South Africa belonging to the Barnato-Joel group.

The annual general meeting of the Johannesburg Consolidated Investment Company, Ltd., was held in Johannesburg on November 26, 1918, Mr. John Munro presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, 1918, said the total book value of the assets was £4,928,894. The gross profit for the year under review amounted to £225,739, a small increase of £1,700 on last year's figures. The working expenses, including income tax, war donations, staff bonus, etc., amounted to £25,000, a decrease of £4,380 as compared with the previous year. This gave a net profit for the year of £200,739, about £6,000 more than for the previous twelve months. The dividends absorbed the sum of £197,500. The arrangement made by their permanent chairman, Mr. S. B. Joel, for the control and disposal of the diamond output continued to work to the benefit of all concerned. The gold production of their group of mines reflected a very considerable increase from £4,500,000 to £7 760,000, or nearly 75%.

At the Consolidated Langlaagte the year started off badly with the heavy rains which occurred in January and February. The consequent flooding of the mine interfered considerably with the progress of underground operations, and unfortunately very little shaft sinking had been possible. There had been a continual rise in the cost of imported stores, and further increases of pay had to be made to the European employees. All these factors had made for increased cost of working and lower profits. For October the working costs were over 20s. per ton, a rise of 3s. per ton as compared with the average for 1917. The development of the mine had been kept going regularly, and the ore reserves had been maintained.

Profits at Government Areas had shown a steady and gratifying improvement for some months. There had been a marked increase in the fathoms mined, combined with an increase in the mill grade, and they had fortunately been able to maintain the scale of development with only some little sacrifice of the tonnage milled. The reefs exposed by the development work were of excellent widths and values, and there was no doubt that the ore reserve position at the end of the year would show a further substantial improvement on that for the previous year.

Satisfactory progress had been made at Langlaagte Estate during the year. The heavy rains which occurred in January and February had a serious effect on underground operations, but once this difficulty was overcome the monthly profits had shown a steady improvement, and the outlook to-day was promising. The grade of the ore milled had improved, and, notwithstanding the increased cost of stores and white labour, working costs had been kept in the neighbourhood of last year's average. The average value of the reef exposed by recent development had been quite satisfactory.

At the Randfontein Central the present year had been one of almost continued difficulty. There had been strikes and floods, and at the present time they were suffering from a very serious native labour shortage. The floods were extremely serious. Practically all sections were more or less flooded for some weeks. There were employed underground in the mine at the present mine only 12,750 natives, against an average of 15,084 for 1917 and 17,000 in the early part of that year. Every effort was being made to meet the position by the installation of machine drills, but there was an economical and practical limit to this, and the tonnage milled must necessarily be a good deal short of the capacity of the reduction plant until labour become more plentiful.

The additions to the reduction plant at Van Ryn Deep, bringing the capacity up to 54,000 tons per month, were completed and brought into operation early in July. The tonnage thereafter increased somewhat, though not to the extent anticipated. Costs were also higher, and in consequence profits, although well maintained, were somewhat lower than was hoped for. Development throughout the year had continued to expose reef of excellent width and value.

Recent results from the Witwatersrand mine had not been too satisfactory. The native labour supply was totally inadequate for the requirements of the mine. The ore from reclamation work in the outcrop section had fallen off, and consequently it was necessary to concentrate operations in the deeper sections. Development work since the beginning of the year had given about 50% payability, having a value of 400 inch-dwt. over the payable footage driven. These results were fairly satisfactory for this district.

Preliminary operations were commenced at New State Areas in March last, and since then considerable progress had been made with the erection of buildings and plant. Although it was impossible to import plant from overseas, every effort was made to install permanent equipment wherever possible. Wooden headgears had been designed of a sufficient height and structure as would render them permanent, and the hoisting engines, which had been purchased locally, were also suitable for the permanent installation. The permanent sinking equipment was nearing completion, and a start had been made in sinking the two shafts, which had reached a depth of 105 ft. and 103 ft. respectively at October 31. It was expected that the reef would be intersected at a depth of 3,600 to 3,800 ft.

Ginsberg, New Unified Main Reef, and New Primrose Gold Mining Companies continued to work throughout the year under the adverse conditions prevailing, which had a marked effect on their profits. It was hoped that they would continue to earn profits for some time to come. At Glencairn Main Reef it had become necessary, owing to the exhaustion of payable ore, to cease mining and milling operations. A large quantity of accumulated slime remained to be treated, from which it was hoped to secure a fair profit.

Mr. G. Imroth seconded the adoption of the report and accounts and the resolution was carried unanimously.

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.Sc., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone *London Wall 8938*. Telegraphic Address: *Oligoclase* Codes: *McNeill*, both Editions.

BRANCH OFFICES: 420, Market Street, San Francisco. 300, Fisher Bdg., Chicago.

SUBSCRIPTION { U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XX. LONDON, MARCH, 1919. No. 3.

CONTENTS.

EDITORIAL

READERS will notice that our section devoted to statistics of production is considerably expanded this month by the addition of new tables.

BORE-hole surveying has recently engaged the attention of Dr. Henry Briggs, head of the mining department at the Heriot-Watt College, Edinburgh. An illustrated account of his apparatus appears in another part of this issue, under the heading of recent patents published.

CHANGES have recently been made in the method of publishing two journals relating to mining. The *Canadian Mining Journal* now appears weekly instead of twice a month, and the *Journal* of the Chamber of Mines of West Australia is now issued quarterly instead of monthly.

THIS month the House of Lords has been engaged with the appeal of the Amalgamated Properties of Rhodesia (now the Rhodesia Exploration Co.) against the judgments of the Court of Chancery and the Court of Appeal, given in favour of the Globe & Phœnix company. Judgment had not been delivered when we went to press.

COULD not the writer of romance in the Middle Ages found a weird story of fatalism, or even of Satanic participation, on the burning of Tehidy Mansion? For nearly six hundred years did the Basset family rule in the Camborne district of Cornwall, and for over a hundred years extracted fat royalties from the mines, of which Dolcoath was the most famous. The present head of the family sold his great possessions two or three years ago, and the house had just been converted into a sanatorium as a County War Memorial. Oh! the pity of it that a building that had been converted to a useful and beneficent purpose should be destroyed by fire and nothing but the grey stone walls left standing.

AMID the many public arrangements made in connection with reconstruction and the establishment of new government ministries, it seems a pity that a step in the opposite direction should be contemplated with regard to the Department for the Development of Mineral Resources under the Ministry of Munitions. Apparently this department is to be abolished at an early date and the responsibility of keeping track of home mineral resources is to be handed over to the Imperial Mineral Resources Bureau, now in course of formation. Surely it is bad policy to disband an organization of practical mining men who have studied the mines and prospects in this country during the past two or three years, and thus to lose all their personal experience and competence to suggest plans for the future development of our non-ferrous deposits.

JUDGING by certain announcements made by members of the Government, there seems to be a good chance of the Channel Tunnel being constructed in the near future. Plans are also being considered for the driving of tunnels under the Bosphorus and below the Straits of Gibraltar. We have referred on several occasions to the Channel Tunnel project, giving plans of the route.

IT has been the practice of this Magazine to depart occasionally from the strictly technical, and to publish articles of human interest. In the present issue will be found an article of this type, recounting the experiences of a British prisoner of war in Germany. The case against the Germans as regards brutal treatment of the helpless has been to some extent spoilt by the circulation of stories that have proved to be false. It is well, therefore, when a witness of undoubted integrity comes forward with his testimony, to disseminate his record of experiences among those who know that his word is good. The writer, Mr. J. C. Farrant, is well known among mining engineers as the London manager for the Hardinge Conical Mill Company, and the readers of this Magazine will accept his account as a plain and straightforward recital of facts. For political reasons the names of the officers who perpetrated the outrages are withheld. The personal responsibility of these bullies is being adjudicated by an official committee of inquiry.

AT the February meeting of the Institution of Mining and Metallurgy, Professor S. J. Truscott presented additional evidence relating to the physics of concentration of slime tin, together with a summary of conclusions founded on his extensive series of investigations. These conclusions are reproduced in the Mining Digest elsewhere in this issue. His main point is that the efficiency of a sloping surface as a catcher of cassiterite is greatest at the top of the slope, and that therefore it would be good policy to have short slopes and a series of operations. Another point is that re-grinding of fine sand helps to increase the recovery. This conclusion may be contrary to current ideas, but, while it will not win more tin that is already slimy, it will catch some of the tin that previously passed down the surface as mixed tin and gangue, for some of even the finest particles are composite in this way. It is to be hoped that some mine will test Professor Truscott's principles on a working scale. It would not cost much to do so.

THE British Science Guild is an organization that does excellent work in bringing together the scientist and manufacturer. Its supporters have the gratification of being able to say that the Guild was not a product of the war, for they do not belong to that class who require a violent knock on the head before an idea penetrates their brains. It is well to know that the Guild's exhibition at Manchester was as successful as that held at King's College, London, last summer, and that the results at both have been so encouraging as to decide the Guild to hold another in London next June. This exhibition will be held in the Central Hall, Westminster. It will be specially interesting because a great many inventions can now be shown that were dead secrets during the war. Another aspect of the present position of science worthy of note is that Professor R. A. Gregory, the leading spirit of the Guild's exhibition, is also managing editor of *Nature*, a paper that used to be severely non-utilitarian, but which under his guidance has become distinctly on speaking terms with commerce.

The Gold Output.

The estimation of the output of gold throughout the world becomes increasingly difficult owing to war conditions. At the time of writing we have the African and Indian figures, and most of the Australian returns, but the New Zealand and Canadian figures have not yet come to hand. Of countries outside the British Empire, the United States has furnished a preliminary estimate, and we are able to give approximate figures for the Belgian Congo. Of British dominions not yet reporting, besides New Zealand and Canada, are South Australia, Tasmania, British Borneo, New Guinea, British Guiana, and Nigeria, but the figures for these producers are not of prime importance in the world's total. The accompanying table gives the

	1917 £	1918 £
Transvaal	38,323,921	35,768,688
Rhodesia	3,495,391	2,652,250
West Africa	1,529,977	1,333,553
India	2,214,000	2,061,900
Queensland	744,500	553,750
New South Wales	349,000	370,000
Victoria	846,540	678,000
West Australia	4,136,600	3,725,000
Federated Malay States	70,346	70,948
Sudan	67,500	50,200
United States	17,190,000	14,064,000
Congo	377,000	545,000

figures as far as they are available. It will be seen that decreases are general, and only the Belgian Congo gives promise of things to come. Probably Canada will show a slight decrease on 1917, the figures being probably under £3,000,000, but during the current year, with more labour available, the output should expand to normal and even exceed that of 1916. Probably South America will have produced about the same as in 1917, say £3,000,000, and Mexico may be taken at £2,000,000, and Japan and Korea at £3,500,000. But we are unable to estimate the results in Russia, Siberia, China, Madagascar, Dutch East Indies, and Austria. In making a general total estimate, it may be reckoned that the output of gold for 1918 throughout the British Empire was £51,500,000, and for the world £78,000,000. In 1917 the Empire's output was £56,500,000, and in 1916, £60,000,000; while the corresponding world's figures were £88,700,000, and £95,600,000.

Helium.

During the last two years many mysterious paragraphs have appeared in the public press announcing that the belligerents had discovered a new gas suitable for balloons and air-ships, nearly as light as hydrogen, and having the great advantage of being not inflammable. Those in authority took pains to cause the circulation of another rumour to the effect that the gas was argon, the object being to introduce an absurdity, and thus serve to discredit the said paragraphs, and divert attention from an important secret enterprise. The necessity for reticence is now removed, and the Admiralty's Board of Invention and Research has permitted the publication of some details. In addition, Mr. F. G. Cottrell, of electrostatic-precipitation fame, when presented with the Perkin medal in America, replied to the accompanying address by giving an account of the participation of the United States Government in obtaining supplies of this buoyant, non-inflammable gas. It is now possible to mention that this gas is helium. Helium is one of the inert gases of the atmosphere, existing in the proportion of one part in a quarter of a million. It has been found in certain rare minerals, and in mineral springs, of which the King's Well at Bath is a notable example. It is known to be a constituent of fire-damp and of natural gas. At the outbreak of war the late Sir William Ramsay drew the attention of the War Office to the advantages that would accrue from its use, and at a later date the Admiralty, through Sir Richard Threlfall, Professor J. C. McLennan, Sir Ernest Rutherford, and others, took up the inquiry as to available sources from natural gas. At first these investigations were confined to occurrences throughout the British Empire, but afterward, on the United States joining the Allies, the representatives of the two countries conducted the work conjointly. Under the auspices of the United States Bureau of Mines, the researches of Dr. H. P. Cady, undertaken ten years ago in connection with the presence of helium in some Kansas natural gases, were revived. The matter was put before the two firms of gas-liquifiers, the Linde Air Products Co. and the Air Reduction Co., operating the Linde and Claude processes respectively, and in addition the Norton-Jeffries process was examined. Eventually the first two companies erected plant at North Fort Worth, in Texas, while a Norton-Jeffries experimental plant was built 100 miles to the north-east, at Petrolia. The plants of each of the two companies were capable of extracting 7,000 cubic feet of helium per day from gas averaging 0·9% by volume. As a matter of fact, however, a large part of the gas supplied contained only half this amount. The details of the process of extraction need not be given here, and it is only necessary to say that, as helium is difficultly liquified, it can be readily separated from the other constituents of natural gas, which are more easily liquifiable. The residual gas contains other constituents than helium, and further steps are required to bring the helium to about 93% pure. At the time the Armistice was signed, 147,000 cu. ft. of helium of this grade was on the dock ready for shipment, and it was probable that in a year's time from that date the output would have been 50,000 cubic feet per day, produced at a cost of not more than 10 cents per cubic foot. With regard to the properties of helium, its lifting power is about 10% less than that of hydrogen. By a system of electric heating its volume and consequently its buoyancy can be increased. As we have said, it is non-inflammable. In addition, it has the important property of not diffusing so rapidly as hydrogen through the envelope, and thus the waste is much less. This utilization of helium is not by any means the least interesting scientific development instigated by the war.

Petroleum Enterprises.

At the present time petroleum is attracting much attention among both mining engineers and the controllers of capital. For this reason the paper read by Mr. Montague Summers before the Institution of Petroleum Technologists last month, entitled the "Financing of Oilfields," deserves special notice. Many of his points are of great importance, and deserve more elaborate discussion than we can give in these pages. Brief reference to some of them, however, may be made. In the first place, he shows that prospecting for oil is usually easier than prospecting for gold and other metallic deposits, at any rate under the present conditions of development and knowledge of the earth's crust. The surface indications are usually much more obvious, and as regards the favourable structure of the rocks below, the geologist can generally indicate more surely the right place to look for oil than for copper or lead. In prospecting at depth by bore the oil provides its own evidence of quantity, whereas the diamond-drill merely proves the two inches through which it passes. After an oil reservoir has been located, the sinking of wells and the raising of oil are vastly simpler matters than shaft-sinking and the driving of levels in a metal mine. These comparatively favourable conditions do not imply an absence of the speculative element from the oil business. While with judicious advice from the geologist and oil engineer the adverse elements may be reduced, there is always the chance that the results of prospecting may be either negative or bring an immense fortune.

Another point made by Mr. Summers is that development of oilfields should be under some sort of national control. As oil is a liquid, it can shift its home, and it cannot be confined within the limits of surface demarcation. To secure justice to the owners of mining rights, the whole reservoir should be taken as an indivisible property. It is wrong that a neighbour should be permitted to sink a well on adjacent ground and thus virtually steal the discoverer's wealth. Such a control would also serve the important purpose of preventing over-production and wastage of oil. Another reason for urging national supervision is that the ownership of oil lands and the ultimate destination of the oil should be safeguarded for the Empire's requirements. It is urgently necessary that the Empire's oil resources should be thoroughly investigated and conserved. One prominent reason for such a policy is that the authorities in the United States, the great present producer, are inclined to believe that future discovery will not keep pace with the demand, and that unless output and export are restricted a serious shortage will be experienced within two decades. Under these circumstances the Empire's resources will have to come to the aid of supplies. Taking into consideration the importance of oil to the Navy and Army, and also the necessity of regulating and protecting production, it is probable that national financial participation will be advisable and even necessary. The case of the Anglo-Persian Company forms an example of the excellent results and many advantages of such a control and participation. Mr. Summers, in his paper, presented figures showing that investment in oil ventures has been on the whole highly profitable, and that less capital has been squandered in futile proposals and swindles than in most branches of mining. Any placing of Government funds for the exploration of oilfields may therefore be considered as likely to produce cash revenue on the outlay as well as reaping political and trade benefits for the community. As we have said, the aspects of the oil question as presented by Mr. Summers deserve serious consideration.

The Value of a Patent.

During the last few years the old question as to the value of a patent has arrived at an acute stage. Not even the war diverted the attention of inventors from their grievances, and the Government, in 1917, was obliged to attempt to allay agitation by introducing a bill into Parliament incorporating some modifications in method and procedure. These proposals were so futile and unsatisfying that the bill had to be withdrawn, with a promise of something better. Since the signing of the Armistice, manufacturers, inventors, and technical societies have renewed their agitation, and have combined to bombard the Board of Trade. A great many reforms are needed. At the present time the most pressing desideratum is that the life of all current patents should be extended by at least four years, for during the war it is clear that most inventors have not been able to reap advantage. This, however, is a special point and does not constitute an item in permanent policy. Nevertheless the Board of Trade is assuming its usual stubborn attitude, and unless some new pressure is brought to bear will refuse to move in the matter. Of larger questions may be mentioned the great cost of taking out patents throughout the British Empire, the short life of a patent, and the failure of the Government to guarantee the validity of a patent. With regard to the first point, each constituent part of the British Empire has its own patent establishment, and the total cost of protection throughout the Empire amounts to at least £1,400. If an inventor has a series of patents the charges are obviously ruinous. On the second point it is only necessary to say that fourteen years is nowadays too short a period of protection. The many complicated and difficult problems forming the basis of research and experiment occupy several years in development and application to the best advantage, with the consequence that before the invention is properly established a large slice of that fourteen years has expired. A prolongation of the period of protection is the patentee's just right.

The most vital of the three points is undoubtedly the third. A patent never afforded real protection. In the old days patents were issued to all and sundry. As long as application was made in the prescribed official form, so-called protection would be given to a process for extracting gold from wheat stalks. No search was made in connection with prior knowledge or publication, and many patents were obtained for old methods and process. Ten years ago, reforms were introduced, whereby some amount of preliminary official search was instituted, but the result of this search consists chiefly of requiring the patentee to state in his specification how his idea stands with regard to the previous patents brought to his notice. The reforms certainly eliminated many absurdities and have made it necessary for the patentee to define his claims more precisely. The ultimate goal of the inventor, the security of his patent, is, however, just as far away as ever. The validity of a patent still rests on a decision of the law courts, and the cumbrous procedure of the High Court, Court of Appeal, and House of Lords has to be invoked before the question can be finally settled. This litigation is costly and it drags along for years. Not only are the patentee's financial resources strained, but his inventive genius is diverted from its proper channel and is upset by mental anxiety for the safety of his position. The judges and counsel engaged know little or nothing of the technicalities of science, and are unable to weigh the evidence as to current knowledge and interpretation of scientific research at the date of application. Each side, and also the Court, has to rely on professional witnesses who often are obliged to give evidence quite at variance with their own personal opinions and convictions. Among all this tangle of argument, the judges and counsel manage to find occasionally some opportunity of uniting science and law, and under this almost accidental condition are able to produce some sort of legal judgment. Under the shield of costliness and speculative doubt the wealthy infringer can afford to take risks and snap his fingers in the inventor's face. He can afford to retain legal and technical advice on a grand scale whereby loopholes in the armour of the inventor can be detected, loopholes real or imaginary, but appealing to the legal mind.

A cure for the present uncertainty as to validity is difficult to suggest. The petitioners representing the technical societies are in favour of the establishment of a patent court analogous to the present commercial court, or alternatively of the appointment of advisers or assessors, as in the case in the Admiralty court. By this means it would be possible to obtain more intelligent adjudication, but the expense and the onus of proof would still stand with the inventor. It is obvious that what the inventor and manufacturer desire is that the validity should be definitely settled before the granting of the patent. It seems to us that the machinery for such a practice already exists. At the present time many patent specifications are open for public inspection before acceptance, and in any case, after the acceptance and publication, objections may be laid before the patent is finally sealed. The objection urged to any extension of this system is based on the fact that few people read the weekly lists of applications and acceptances issued by the Patent Office, and that unless a rival inventor happens to be on the same track at the same time evidence of past or current knowledge would not be sent to the Controller of Patents. This difficulty, however, might be surmounted if the technical and trade press undertook to co-operate with the Patent Office in the matter of publicity. In the domain of non-ferrous metallurgy, for instance, the publication in this Magazine of notes of applications and acceptances would surely reach the eye of all those who would be likely to know whether the ideas were old and whether the specifications clearly described the methods of use. We believe that the press of this country would treat inventors fairly if this procedure were generally adopted. We give the suggestion for what it is worth, and invite its consideration on the part of the committee of technical societies.

Government Statistics Again.

In our last issue we entered a protest against the dilatoriness and incompleteness which characterize the collection of Government statistics relating to the production and movements of metals and minerals. We then had space only for reference to the Board of Trade Returns of imports and exports, and we promised to give further examples on another occasion. We accordingly revert to the subject once more. The Board of Trade Returns, as we said, are not published dilatorily, but they are tantalizingly lacking in detail. When we come to the yearly reports of output in the British Isles, words fail to express the feeling of disappointment and even resentment which the delay in publication and absence of particulars arouse within us. It is true that the Home Office issues a bald preliminary statement within two months of the end of each year, giving an estimate of the total figures for the outputs and values of the various minerals and ores, but these only cover the proverbial half-sheet of note paper. From eleven to fourteen months afterward, the so-called complete report is officially issued. This gives the figures of the earlier table in a revised form, with the estimated amount of metal obtainable by smelting the ores. Then follow tables relating to some of the individual minerals and ores, in which the figures of output and value are divided as to counties. In order to give more body to the report, statistics are also included dealing with the amount of coal carried from the various coalfields by each individual railway. There are also some very brief explanatory notes and general statements relating to output, imports, and exports. The report for 1917 occupies twenty-six foolscap pages. If the Home Office were more economical of paper, the whole of the information could be given on one-third the number of pages. It is difficult to say what value this report is to the public. As the Home Office has the legal right to demand information from the mines, there is no reason why all this delay and barrenness should arise. As for the figures by county without reference to individual mines, these are dry, lifeless, and unsatisfying. As we have said, only some of the minerals and ores are classified by county, and in this connection no word is mentioned of bauxite, fluor-spar, ochre and umber, lignite, slate, uranium ore, and others. In the days of Sir Clement Le Neve Foster, the details for which we call were given and the reports were issued with promptness. Moreover, other items of useful information were given, such as the names and addresses of the smelters. No doubt the reply to these criticisms will be the stereotyped casting of the blame on the war. If the interpretation of that excuse is that the war has had a bad influence on the Government statisticians, we agree. The war is, we hope, now over, and the statisticians will have the opportunity of pulling themselves together and reforming a publication which at present is only a laughing-stock.

So far we have confined our attention to official statistics prepared in this country. Improvements are also desirable in the presentation of figures of production in the Overseas Dominions. This is a different matter and a rather more complicated subject than appears at first sight, and it involves a number of points for consideration. Let us take the case of gold output. In the first place, the London representatives of the Dominions do not generally appear to be in close touch with their headquarters in the matter of metal and mineral outputs. For instance, the output of gold in Victoria for 1918 was known in Melbourne on January 20, but advice in London will only be available on the arrival of the Australian papers. The West Australian Government is more active, for the figures are sent by cable. The Queensland and New South Wales Governments only cable round figures in ounces every month, with the result that at the end of the year the totals may easily, and usually do, become considerably wide of the mark. Why the Queensland figures should be cabled in round numbers is not at all clear, for at the time of despatch the detailed figures for ounces and value are known, and are in fact published in the Government mining journal. As regards West Australia, we have said that the Government cables the gold production for the year promptly. On the other hand, the monthly figures as cabled by the Chamber of Mines do not represent the outputs, but the amounts delivered to the Mint and reported for export. The New Zealand Government, before the war, used to publish monthly figures of gold exported and not those for production. The issue of these figures is apparently still in abeyance, and neither in this country nor in the Australasian press do we find any mention of them. At the present time, yearly figures for the production of gold in New Zealand, South Australia, Northern Territories, Tasmania, and Papua are not available here until the arrival of the yearly reports of the Mines Departments. Other parts of the Empire for which gold-production statistics are difficult to obtain are the Sudan, British Borneo, British Guiana, and Nigeria. Though we have reason for suggesting more liveliness and clarity in the issue of gold figures in several parts of the Empire, it is only right to congratulate those countries which are prompt, though it must be confessed that only in the case of Canada are our thanks due to the government authorities, those generally deserving the credit being the Chambers of Mines or other commercial organizations. The monthly and yearly figures for the Transvaal, Rhodesia, West Africa, and India are models of promptness and accuracy. The Transvaal and West African figures are issued by the Chambers of Mines, those for Rhodesia by the Chartered company, while those from India come by cable from the individual companies. Also, the West Australian Chamber of Mines issues monthly returns with commendable promptness.

Before leaving the consideration of the figures for gold outputs, it is well once more to draw the attention of those responsible for the reports to the necessity for adopting a uniform measure. In the old days much confusion arose owing to some reports being in fine ounces, and others in ounces of crude bullion, standard ounces, par value, and realized value. Bullion ounces and standard ounces have fortunately mostly disappeared nowadays, but realized value still causes trouble. It is never certain how much is deducted from the par value of the gold for the commission to the banks or metal brokers for realization, for cost of refining the bullion, or for cost of transport and insurance. These charges lessen the producers' receipts, but they do not reduce the output. Clearly therefore the realized value is not the true gauge of the output.

The method of presentation of figures for the output of base metals in the Dominions is open to much criticism. It is not easy to obtain exact returns. For instance, the output of lead and zinc concentrates at Broken Hill is difficult to obtain, if at all. The Federated Malay States does not now issue any statement of tin concentrate delivered to the smelters. British Columbia announces the output of copper and lead in dollars. And so on. The newly created Imperial Bureau of Metals and Minerals might well begin with this most elementary subject, the prompt and accurate collection and publication of statistics of output.

REVIEW OF MINING

Introduction.—Negotiations for the peace settlement and the establishment of a League of Nations proceed slowly. In this country the labour question continues acute. The Coal Commission is giving some interesting and even exciting reading. In particular, Sir Richard Redmayne's views as to possible methods of decreasing underground costs provides evidence that a low level of wages is not the sole means of producing coal cheaply. In non-ferrous mining circles things are going slow, for the big Government stocks of base metals, both here and in America, overshadow the market, and, with uncertainty as to the prices and future demands, new mining enterprises necessarily stand aside. An event of note is the absorption of the Mexican oil interests of Lord Cowdray by the Shell company. The Magadi soda enterprise in East Africa is to be expanded, and additional capital is being raised. It is reported that the Great Cobar copper mine in New South Wales is to be closed; this is an unofficial report, but it is likely to be true, as the conditions could not stand the fall in the price of copper.

Transvaal.—The labour position is improving, and recruiting is on a more extensive scale. More natives are coming in, and several mines that have been short of labour are now able to recommence development.

A cable message gives the results at the East Rand Proprietary Mines during 1918. The ore milled was 1,372,300 tons, as compared with 1,741,300 tons in 1917, and over 2 millions in 1916. The yield per ton was 23s. 3d., and the working cost 22s. 6d., as compared with 21s. 11d. and 19s. 9d. in 1917, and 24s. 4d. and 19s. 3d. in 1916. The working profit was £52,916, and the net profit transferred to appropriation account £23,526. There are debentures amounting to £835,620 still unredeemed. The ore reserve is estimated at 2,200,000 tons averaging 6·5 dwt. per ton. The outlook is rather brighter than a year ago, for in the Driefontein, Hercules, and Cason-Cinderella sections developments in depth have revealed ore, though in comparatively narrow shoots. There is no encouragement, however, to reopen the southern section of the property.

The fight for the control of Witwatersrand Deep has ended with a victory of the local shareholders' association. In the polling the association obtained 122,953 votes as against the Central Mining's 96,767. It will be remembered that objection was raised to the Central Mining using the votes of the enemy shares at present in the hands of the Custodian of Enemy Property. These votes amounted to 59,708. The Central Mining had used them before and had thereby obtained a majority. The result of the poll is that the Central Mining directors who had put up for re-election have withdrawn, and Messrs. F. C. Holland and Horatio Gamble were elected. These gentlemen subsequently co-opted Messrs. Bleloch, O'Flaherty, McAllister, Ellis, Deeble, and Rosenschweig to the board. Since writing the foregoing, we hear that Central Mining has lodged an objection to the scrutiny of the votes as conducted by Messrs. Holland and Gamble.

A serious accident occurred at Modderfontein B last month. A compressed-air main burst, killing four natives and injuring thirty. The shaft had to be closed during the time required to repair the main.

The ore reserve at Brakpan on December 31, 1918, was estimated at 2,718,000 tons averaging 8·7 dwt. per ton, as compared with 3,268,000 tons averaging 9·2 dwt. on December 31, 1917. For the half-year July to December, 1918, the tonnage developed was 141,000 tons averaging 11·34 dwt. These measurements all assume a stoping width of 67 inches. The yearly amount mined is about 800,000 tons.

At Springs Mines, the ore reserve at December 31 last was estimated at 2,368,000 tons averaging 9·3 dwt. per ton, as compared with 2,567,000 tons averaging 9·8 dwt. the year before. During the half-year July to December, 1918, the tonnage developed was 248,000 tons averaging 10·5 dwt. The monthly capacity of the metallurgical plant is 40,000 tons.

Modderfontein Deep reports the ore reserves at December 31 last at 3,450,000 tons averaging 8·8 dwt. per ton, as compared with 3,320,000 tons averaging 8·7 dwt. at the end of 1917, in both cases the stoping width being taken at 78 inches.

The speculative chances of the southern and south-eastern portions of the Far East Rand have not received much attention in this country, owing to the restriction of capital investment during the war. The success of developments in depth at the Sub-Nigel provided great encouragement to those who believed in the future of the district. The Consolidated Gold Fields, the controllers of Sub-Nigel, extended the operations north-westerly into Grootfontein; Messrs. L. Ehrlich & Co. have secured the northern part of Klippoortje; Amalgamated Properties of Rhodesia (now the Rhodesia Exploration Co.) is working on Maraisdrift; while Mr. W. Bleloch is developing the property of the Southern Van Ryn Reef Gold Mining Co., Ltd., to the north of Sub-Nigel, the south portion of Klippoortje and the Tulipvale belonging to Houtpoort, Limited, and the Boschfontein to the west of Heidelberg, in the last two cases in connection with Dr. Hans Sauer. Dr. Sauer is also drilling on the Boschhoek, Koppieskraal, and Eendracht, farther to the north and west of Heidelberg. Between the Nigel district and Springs there are two farms, the Vlakfontein and Spaarwater, belonging to the Lace interests; these are receiving financial attention from Sir Abe Bailey and Mr. S. B. Joel, and more will be heard of them before long. Undoubtedly Mr. W. Bleloch's is the genius which has inspired the recent activities in the south-east of the Far East Rand. His geological theory is not the orthodox one. He holds that the deposit worked in the Far East Rand should be called the Van Ryn reef, that it is entirely different from the Main Reef Series, and that the Main Reef Series passes to the south-east beyond the Boksburg break. There are two reefs in the Nigel and Heidelberg district, which he calls the Nigel and Van Ryn reefs. We have said that his views are not orthodox, but as the orthodox views are not at all conclusive, seeing that the characteristics of the Far East Rand deposit are different in many ways from those of the Main Reef Series in the Central Rand, there is no reason why Mr. Bleloch should not be right. Anyhow payability is of more importance than theory, and evidence of that is what we are now waiting for.

Rhodesia.—The output of gold during January was reported at £211,917, as compared with £192,870 in December and £253,807 in January, 1918. The individual returns from the mines show a steady recovery from the depression caused by the influenza.

The case of the Amalgamated Properties of Rhodesia against the Globe & Phœnix with regard to the ownership of gold worked below the John Bull claim has been before the House of Lords and judgment is reserved.

West Africa.—The output of gold during January was £104,063, as compared with £112,621 in December and £107,863 in January, 1918. At Abbontiakoon the ore treated gave much lower returns than the average of the reserve, the figure being 28s. 10d. as compared with an average of 45s. The Ashanti Goldfields output was again lower than normal, owing to the after effects of the influenza epidemic.

Most people do not know that cassiterite is found in Gold Coast Colony any more than they are aware that gold is mined in Nigeria. Mr. A. E. Kitson, the director of the Gold Coast Geological Survey, wrote a brief report in 1914 relating to the alluvial and lode deposits near Winnebah, which had been discovered by a member of the firm of Innes, Macdonald, & Seale. These deposits are now interesting the Stock Exchange, where something is heard of the shares in the Appollonia Gold Fields, Limited, which acquired the firm's concessions. Two other companies owning concessions in the same neighbourhood are the London Dublin Gold Coast Syndicate and the Dunkwa Mining Syndicate.

Nigeria. — As mentioned last month, the Tin Areas of Nigeria is to change its name to the British West African Corporation, and to issue additional capital. Resolutions have been passed to increase the capital from £200,000 to £500,000 by the issue of 1,200,000 new shares of 5s. each, and Treasury consent has been obtained. The new money will be used in general merchanting and transport business. Mining men often think that there is nothing but tin in Nigeria. As a matter of fact, Nigeria is already a most important source of raw material, mostly vegetable, and promises to expand vastly as a supplier of vegetable and animal products.

The Juanita Mines of Rhodesia, Ltd., after four years of quiescence, is now circulating reports as to its intentions in Nigeria. It has mining rights on the Bilidi river, Bauchi Province, and announces that a regular output will commence in May. Application has been made to the Treasury to allot 30,000 unissued shares of 5s. each.

Australasia.—The latest cabled reports indicate that the influenza epidemic has passed in Victoria and New South Wales. The experience of medical men there is that inoculation has been effective in moderating the disease.

Last month our Melbourne correspondent referred to the opening of iron ore deposits at Cadia, New South Wales, by Messrs. G. & C. Hoskins, of Lithgow. The deposit to which reference was made is the Iron Duke, particulars of which are given in an article in this issue. The branch line connecting with the railway at Spring Hill has been completed, and also an aerial ropeway, ¾ mile long, from the quarry face to the railhead.

Not long ago we mentioned that the manufacture of galvanized iron was being established in Australia. The Broken Hill Proprietary now announces that the construction of the works has been commenced at Newcastle, New South Wales. This industry has been founded conjointly with John Lysaght, Limited, of Bristol. Newcastle promises to become a great manufacturing centre. Other enterprises now in hand are the nail and wire works of the Austral Nail Co., the cement works of the Newcastle Slag Cement Co., and the oil, grease, and disinfectant factories of Paul & Gray, Ltd. Shipbuilding at Walsh Island is another important new industry.

Alkali manufacture in Australia has been noted in the pages of the Magazine several times recently. News is now to hand that the Mount Lyell company intends to start the electrolytic process at their Yarraville phosphate works near Melbourne, employing sea water as the source of salt. A similar plant is to be erected at Edithburg, at the southern end of Yorke Peninsula, South Australia, by the Standard Salt Company. These works have been designed by American chemists.

In another part of this issue particulars are given of the Northampton lead-mining district in West Australia, which has had a wave of prosperity owing to the steady demand and high price of lead. Since the Armistice the lead market has been demoralized, and the Fremantle Trading Company, which operates the smelter and most of the mines, has been obliged to cease smelting and mining. This stoppage, it it hoped, will not be for long, for the usual local trade demand for the metal will revive again and the market become steady once more.

The report by Mr. Lindesay Clark, manager of the Briseis Tin Mining company, on the best method of mining the Morwell coal deposits east of Melbourne has been submitted to the Victorian Minister of Mines. These deposits of brown coal are several hundred feet thick and are near the surface. Mr. Clark proposes to remove the overburden by steam shovels, and to excavate the coal by open-cut, using explosives and steam shovels. On a yearly output of 500,000 tons, the pumping charges would not be more than 2d. per ton, and 6d. would be added to the cost per ton of coal for the expense connected with the removal of the overburden. The mining cost is estimated at 18d. per ton, bringing the total cost to 26d. per ton. At the spot where work is to be commenced the overburden is 33 ft. thick, and the thickness of coal to be excavated by this method is 120 ft. As has already been mentioned in these columns, the coal is to be gasified and the power transformed into electric current.

Malay.—The figures for the export of gold, and tin and tungsten concentrates from the Federated Malay States during 1918 are as follows: Gold, £70,948, as compared with £70,346 in 1917; tin concentrate, 37,370 tons, as compared with 39,833 tons; wolfram concentrate, 710 tons, as compared with 421 tons; scheelite concentrate, 111 tons, as compared with 340 tons. With regard to tin concentrate, the decline has been continuous during recent years, the figures for 1913 to 1918 being 50,127 tons, 49,042 tons, 46,767 tons, 43,871 tons, 39,833 tons, and 37,370 tons respectively.

The Tekka company, one of Mr. James Wickett's companies operating in Perak, floated a subsidiary, the Tekka-Taiping, in 1913, and still holds 20,000 shares, which stand in its books at par. These shares are now being offered at par to shareholders in Tekka. As the shares stand at a high premium, the quotation being about £3. 15s., it is clear that Tekka shareholders are in for a good thing.

Canada.—The output of metals in British Columbia during 1918 is estimated by Mr. W. Fleet Robertson, the Provincial Mineralogist, as follows: Gold, placer, $308,000; gold, lode, $3,250,000; silver, 2,886,861 oz.; lead, 19,620 long tons; copper, 28,298 tons; zinc, 16,138 tons; coal, 2,292,068 tons. The output of lode gold, lead, copper, and coal showed slight increases; zinc and silver were rather lower. The increase in the gold output is largely due to the new producer, the Surf Inlet mine, and also to activity at Rossland.

Dr. Alfred Stansfield, of McGill University, has issued a report on the possibility of treating British Columbian iron ores by electric smelting. He states that 50,000 tons of magnetite can be delivered per year, and that this ore is practically free from phosphorus, titanium, sulphur, and copper. He estimates that, with hydro-electric power at $15 per horse-power year, pig iron could be made at just under $30 per ton. It is probable that charcoal could be obtained cheaply from waste wood at the lumber mills. The Provincial Department of Mines has offered $3 per ton as bonus. Before embarking on the enterprise, Professor Stansfield recommends that the iron ore deposits should be developed, water-rights secured, a plant for making charcoal provided, and the latest metallurgical developments investigated and tested.

United States.—The output of lead in the United States during 1918 was estimated at 491,750 long tons, and of zinc 468,860 long tons.

The directors of the Anaconda Copper Company have authorized the issue of $50,000,000 gold bonds, for the purpose of financing the Andes Copper Mining Company, which owns the Potrerillas copper mines in Chile. Half of this amount has been issued to the Guaranty Trust Co., of New York, and the bonds have been placed among bankers. The financing of the South American enterprises has hitherto been effected out of Anaconda profits. The money spent already will be refunded out of the proceeds of the issue of these bonds, and the bonds, which run for ten years, will be redeemed by the South American companies.

Mexico.—The outlook in Mexico is now better than it has been since the days before the recent revolutions. Carranza has strengthened his position, and is endeavouring to get in contact with law and order in other countries. His emissary is in New York interviewing the banks with a view to restoring the public debt of Mexico to its just position, and to securing further credits or renewing financial connection. Concurrently a strong committee representing American, English, and French financial houses has been formed to watch over the interests of foreign investors and capitalists. Roving bands of insurgents are still at large in several parts of Mexico, and we have not heard of the extinction of Villa or Zapata. In this country and in Europe generally the mandate to police Mexico would be readily granted to the United States. After the extermination of the known marauders, only a gentle and kindly policing would be necessary.

The report of the San Francisco Mines of Mexico, operating near Parral, Chihuahua, announces the transfer of the property and the obtaining of Treasury consent to issue the shares to the shareholders in the old company, the San Francisco Del Oro Mining Co. Messrs. Knox & Allen revised the treatment of the ore, which is a complex sulphide, and the plant to treat 3,000 tons per month has been completed. The conditions to ensure regular running are, however, still lacking, for railway transport is undependable. The mill is designed to produce silver-lead concentrate, which is to be sold to the American Smelting & Refining Co.'s smelter at Chihuahua. The tailing is high in zinc, but as there is no present outlet for zinc concentrate, nothing further can be done in the realization of the metallic constituents of the ore.

Colombia.—The shares of the Colombian Mining & Exploration Co. are well known on the Stock Exchange as a medium for speculation, but little definite information from the mines is published. At the meeting of shareholders held last October, the chairman said much about the glowing prospects of the Marmato Hill gold mines. No progress report has been published since, but, instead, the attention of the market has been turned to an oil concession which has been secured. A cabled report from Mr. Rupert Way is brief and couched in glowing but vague terms. It is impossible to give any opinion of the gold and oil projects as business propositions.

Siberia.—The Irtysh Corporation has published a cable from the managing director in Siberia of this group of mining companies. He reports satisfactory progress. The output of coal at Ekibastous during December was 3,000 tons, and 300 tons of coke was produced. The fleet is being put into condition for summer service. The exclusive prospecting rights on the Ridder concession have been extended for a year by the Siberian Government, and at the close of the period the company has the preferential right of locating claims for another five years. Five new claims have been made on promising mineral outcrops on the copper belt, and four on the lead-zinc belt. Prospecting and location of other claims will be continued this summer. The Siberian Government has proposed to the company that it should undertake the production of soda from the alkaline lakes near Ekibastous, and a start on this work is being made.

Spain.—An instance of the growth of international agreement in commercial undertakings is provided by the projects for building new railways in Spain. One of the proposals comes from the English and French Governments, and constitutes part of a plan for the connection of all parts of Europe and Africa by means of railways. The scheme is to build an electric line connecting the French system at a point just north of Bayonne with Algeciras across the bay from Gibraltar. The route is not through centres of population, except Madrid, for local traffic is not desired. The other proposal comes from the United States, and involves the building of docks at Vigo and a railway connecting with Bayonne. This route is devised for the expansion of American trade with southern Europe, and also for the shortening of the time occupied by the journey between New York and Paris.

THE NORTHAMPTON LEAD-MINING DISTRICT,

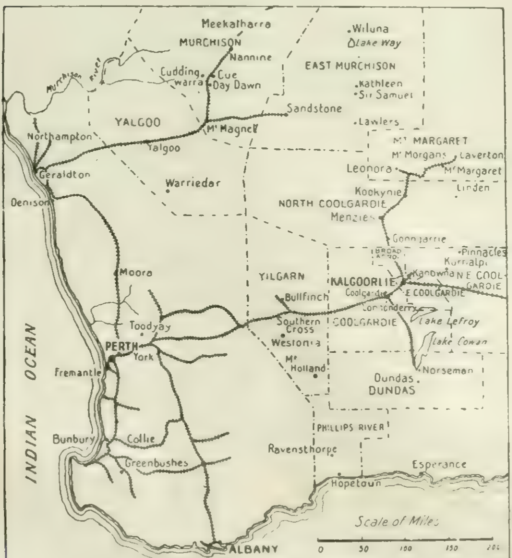
WEST AUSTRALIA.

By C. M. HARRIS, M.Inst.M.M.

The author gives an account of an old lead-mining district in West Australia that showed renewed activity during the war.

THE Northampton mineral field is 200 miles north of Perth, West Australia, and extends from the Chapman River on the south to the Murchison River across a zone 24 miles wide. It is the oldest mining district in the State. The first discovery of copper was made in 1842, in the Wannerenooka mine, but active operations were not commenced until some ten or twelve years after. Several other copper mines were discovered and worked, and then the lead mines were opened up. The former either became depleted of copper or turned into lead, and at the present time there are not any copper mines in operation. The figures available show that the production of copper was 9,394 tons, valued at £148,744, the prices having varied from £35 per ton in 1889 to £108 in 1872. Lead mining commenced in the early sixties of last century, and gradually increased to an output of 3,955 tons in 1877 valued at £47,466. After that it decreased until 1891, when, owing to the price of lead having fallen to £9, it was found impossible to keep going. However, with the high price secured during the past four years, there has been a distinct revival, and at the time of writing the output exceeds 5,000 tons of pig lead per annum, worth approximately £147,000, all of which has been sold to the British Minister for Munitions.

In his report on the district, the Government Geologist, Mr. A. Gibb Maitland, says: "The area is traversed by a series of basic dykes, which are continuous for miles, and parallel to these are lodes of lead and copper, which have already been opened up. These igneous dykes being of deep-seated origin, and as the lodes fill in similar fissures, there is every reason to believe that they will continue downward as far as ever operations are likely to be carried." The same reasons also apply to the extension of the lodes for considerable distances along the line of fracturing. In those mines which are opened up to any extent, the ore-bodies have been proved up to 1,200 ft. in length. A system of judicious prospecting would doubtless open up many more lodes than are at present known, and the excellent results now being obtained at the Surprise lead mine described hereafter, which was discovered in 1917, certainly warrant more attention to this large region than it has enjoyed hitherto. It will be of interest to your readers if I give an account of the various mines and deposits.

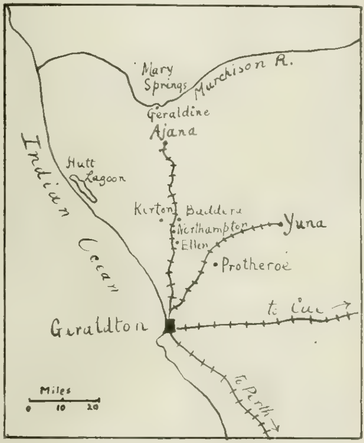


MAP OF PART OF WEST AUSTRALIA
showing position of the Northampton Lead District.

NARRA TARRA.—This mine is, with the Baddera and Wheal Ellen mines, the property of the Fremantle Trading Company, Limited, which treats the ore from these mines at the smelting works at Fremantle, and purchases ores from the other mines in the district, on terms arranged with the Mines Department. The Narra Tarra property consists of 750 acres of freehold land at Protheroe, 13 miles south-east of Northampton, a townsite named in honour of Mr. Protheroe Jones, chairman of directors of the company. The main shaft has been sunk to a depth of 460 ft., and drives have been put in on the lode for a length of 756 ft.; but by including the old workings which are now being re-opened, there is over 1,000 ft. of driving along the line of lode. The ore is taken out over widths varying from 5 to 20 ft., and the output is 25,000 tons of ore per annum, which yields 3,500 tons of leady concentrate of an assay-value of 70·36% lead. At the south end of the workings the lead is replaced by a lode carrying 12% of copper, in the form of chalcopyrite. This feature is of considerable interest, in that the transition from lead to copper is most abrupt, there not being any mixed lead and copper ore as might be supposed.

Steam is supplied from two Lancashire boilers and is used for operating an 8 by 16 in. double-drum winding engine for mine haulage, and also a 32 k.w. electric generator used for lighting purposes, and the motor driving the return water pump at the dam. The crushing and dressing plant is driven by an 110 h.p. suction gas engine supplied from a Mond-type up-draught generator burning wood. This type of generator necessitates the use of a tar extractor. The wood for the generators is cut into about 9 in. lengths by a circular saw, from 6 ft. wood. The ore is trucked from the brace at the collar of the shaft a short distance to the mill, where it is tipped on to a grizzly, and then crushed in a No. 3 Gates crusher. The ore which passes through the grizzly and crusher discharges on to a 14 in. conveyor belt, and is elevated to a bin, from whence it is taken by a conveyor belt to a set of 24 by 10 in. Cornish rolls. The crushed ore from the rolls falls on to a short conveyor belt discharging into a 12 in. bucket elevator, which elevates the ore to trommels. The fine ores passes through the trommel into a bin beneath, and the roughs pass through chutes on to a belt which returns them to the rolls. The fine ore is elevated by a belt from the bottom of the bin to a 30 in. compound May's jig, where it is dressed and separated into concentrate, middling, and tailing, the middling being further concentrated over two Wilfley tables. The mixed concentrate is carted a distance of 3½ miles to the Nabawa railway and railed loose to Fremantle. The tailing until recently has been elevated to the dump by a Frenier pump, but this has now been replaced by a 12 in. bucket elevator. The water supply is drawn from the mine, with the addition of return water from the dam by means of a three-throw pump operated by an electric motor.

BADDERA CONSOLIDATED.— This group consists of 152 acres of freehold land situated some 4½ miles north from Northampton, and is equipped with a plant similar to that on the Narra Tarra mine. The concentrate is carted half a mile to the railway, and trucked loose



MAP OF NORTHAMPTON LEAD DISTRICT, W.A.

to the company's smelters at Fremantle. The output is 21,000 tons of ore per annum, producing 3,000 tons of leady concentrate of an average assay-value of 73%. The main shaft has been sunk to a depth of 455 ft., and north and south drives have been put in a distance of 775 ft. along the main lode. A branch lode off this has been driven on for 247 ft. in a south-easterly direction. The lode varies from 4 to 16 ft. in width, and averages 10·5% of lead.

WHEAL ELLEN.—This property is situated about a mile to the south-west of Northampton railway station, and was re-opened in 1916 by the Fremantle Trading Company. The mine was first worked in 1872. At a depth of 70 ft. the lode was driven on for 1,200 ft., and £16,000 worth of ore was raised. A new vertical main shaft has been sunk to a depth of 135 ft., and a body of fair grade ore is being opened up, over a stoping width of 5 ft. The ore is railed to Baddera, where it is dressed, and the concentrate sent to Fremantle.

WHEAL MAY.—This mine is situated about a mile to the south of Baddera. At the present time it is not being worked. The shafts and old workings show that the lode was opened up for over 800 ft. in length, at a depth of 70 ft. The lode varies up to 8 ft. in width, and, with the characteristic feature of the district, the ore on each wall is of much higher grade than in the centre. The records show that 2,200 tons of concentrate assaying 75% lead were produced. At that time lead was only £14 per ton, which did not show sufficient margin of profit to warrant the cost of development work below water level. It is very probable that, with the present high price of lead, and the increased facilities for transport and dressing, this mine will be re-opened and worked at a profit.

NOOKA.—This mine is two miles west of Northampton, and although the lode is only from 2 to 4 ft. in width, the quality is good. It has produced about 1,000 tons of ore and is opened up at the 90 ft. level. The owners have a small dressing plant consisting of cracker, triple rolls, jigs, and Wilfley table, operated by an oil engine. When first opened up, there was a considerable quantity of zinc blende in the ore, but this is becoming less with depth.

FORTUNE EXPLORATION.—This property was worked half a century ago, being known as the Wheal Fortune Extended mine. It produced 2,376 tons of copper ore averaging 17%, and 2,732 tons of lead concentrate averaging 75%. Owing to the fall in the price of lead and other causes, it was shut down for many years. Subsequently it was floated in England for £60,000 as the Geraldine Copper and Lead Mines, Ltd., on the strength of reports collected from various sources. Most of these reports were written by old Cornish mine captains, with a plenitude of figures and estimates, presenting visions of untold wealth, simply waiting to be converted into dividends. However, little or no work was done by the company, and the property was sold to the present owners, who found a new lode which they are now opening up with encouraging prospects.

KIRTON'S.—A mile to the north-west of the Fortune Extended mine is Kirton's lead mine, which was first opened up in 1873. This mine was extremely rich in parts. The shoots of ore were some of the largest in the district, being worked at a number of points extending over half a mile in length. The mine has been re-opened, and the shafts at the north and south ends of the property are being sunk below the old workings. In the dressing plant, erected by the present owners, a Richards pulsator jig has taken the place of the usual May jig, and the results are stated to be very satisfactory. The want of capital is retarding the opening up of this property, which is one of considerable promise.

GERALDINE DISTRICT.—This centre is on the Murchison River, forty miles to the north of Northampton, and nine miles from Ajana, the terminus of the railway line. Several very promising mines are being opened up. The output is about £4,000 of lead per month out of development work in new ground, which was discovered during the past year. The Geraldine mine was worked in 1857 more or less until 1878, during which period a considerable quantity of lead ore was raised and dressed. It was the best lead mine in the district, but owing to the unfortunate position of the four shafts in the bed of the Murchison River, the floods filled all shafts, and for many years that portion of the mine has never been unwatered. At 320 ft. on the underlie, which is the depth of the main shaft, it is stated that there is 30 in. in width of solid galena, averaging about 70% lead. The property is being worked by tributers. They discovered a parallel lode, which they have opened up for some 200 ft. in length on the surface, on a vein varying from 12 to 36 in. in width. With very little hand picking, the ore can be raised to 75% lead.

GERALDINE SOUTH.—This is another old mine, which some thirty years ago produced 500 tons of high-grade ore from a depth of 40 ft. Owing to an inrush of water cut when the lode widened, the mine was flooded, and the owners had not sufficient pumping power to cope with it. It has recently been secured, and is being opened up, by an English development syndicate, with every prospect of success. The ore from this mine won the first prize for purity at the Melbourne Exhibition in 1889.

SURPRISE.—This is a new mine, which was discovered last year, and has been opened up for nearly 200 ft. in length at water level, 40 ft. The lode averages 8 ft. in width, and assays 50% lead. The ore is picked up to 70%, and the seconds put through a small hand jig. The output of crude ore and concentrate from development on this mine now amounts to £3,000 per month. When the main shaft has been completed to the 100 ft. level, and the lode opened up at that level, the owners expect to turn out £10,000 worth of lead per month.

The lode has been proved at various points on the surface for over 900 ft. in length. Four shafts are being sunk at intervals over this distance on the lode to 100 ft., and at depths varying from 60 to 80 ft. the lode is maintaining its high quality in lead. This ore carries only about ½ oz. of silver to the ton, with a small percentage of copper and zinc, but not in sufficient quantity to interfere with smelting. The north face of the drive is 15 ft. in width and assays 60% lead.

MARY SPRINGS.—This is another old property, and is situated 4½ miles north of the Murchison River. It was worked in 1878, and has now been taken up again. There are three parallel lodes, which occur in an igneous dyke some 160 ft. in width. The dyke itself is so much charged with galena that it is really a lode formation carrying in places up to 20% of lead. Two of these lodes have been opened up for 150 ft. in length, and at the bottom of the shaft, 60 ft., there is 18 in. of ore, assaying 75% lead.

FREEHOLD MINERAL LANDS.—There are two great drawbacks which will have to be surmounted before the Geraldine centre of the Northampton mining district can make the progress that the extent and grade of the lodes warrant. The first is the private ownership of much of the mineral lands, which were alienated half a century ago. The mines were worked for a time and then shut down, and the owners will not work them, and will neither sell the land nor let it on tribute at a fair price or royalty. The freeholders of these lands purchased the mineral rights under an old Act, so that a prospector cannot take advantage of the Mining on Private Property Act, as he can do on lands which were sold in recent years. Consequently, unless he has very good reason to believe that he will open up some high-grade ore, a prospector will not pay the heavy rate of royalty demanded by the owners. There are many old mines which would be re-opened and worked if the owners would sell at a reasonable price or agree to royalties on the net return to the prospector based on a sliding scale, a system so successful on the gold mines throughout the State. At a time like this, when there is so great a demand for lead, the State should have the right to say to the owners, "You must either work these mines, or let some one else do so, paying you a fair royalty, proportionate to their net return." This might be an attack on vested interests, and one that the Government would be chary to do, but the locking up of mines for over thirty years is so serious that strong measures are needed. The second drawback is the need of a public dressing plant for crushing and concentrating the second-grade ore, which will not pay to send to Fremantle. The erection of this is only a matter of time, as the Government will doubtless subsidize one of the mine owners or install a State dressing plant, as soon as it can be kept going. It does not pay to send any ore under 60% to Fremantle, so that only the high-grade ore is hand picked, while the remainder is stacked on the surface, or left in the mine. The freight on the ore from Ajana to the Fremantle Smelting Works is 16s. 2d. per ton. It is bought on 90% of the assay-value, the returning charges being 120s. per ton, so that 65% ore leaves the owners about £8 per ton for mining and profit.

JAROSITE.—This potash-iron mineral is found at Northampton, generally in conjunction with graphite near the contact of the granite and basic dykes. The percentage of potash in the deposit which is now being opened up varies from 2½ to 5%, and can be treated by grinding and roasting, the potash then being in a soluble form. The by-product is iron oxide, which makes an excellent paint. This property is being developed by a local syndicate, which has placed a qualified mineralogical chemist in charge of operations.

SALT DEPOSIT.—Some twenty miles to the west of Northampton there is a large area on the coast called Hutt Lagoon, which carries a very high-grade deposit of salt. This salt is being collected, and put on the market.

CONCLUSION.—From the foregoing, which is but a brief description of mines now in operation, it will be readily appreciated that the attention which it is now attracting is well warranted. This attention will be much increased if some working agreement can be arrived at between the owners of the freehold lands and the Government, so that the old mines, of which at least 15 are now locked up, can be re-opened. I can best conclude by quoting from a report to the State Mining Engineer made by Mr. S. Cullingworth, who was the Inspector of Mines for this district for many years, and now mine superintendent of the Fremantle Trading Company: "The number of metalliferous veins discovered, the extent over which they exist, and the quantity of both lead and copper ore produced, often under very primitive conditions, all point to possibilities ahead, if opened up in an energetic manner."

[The foregoing article was written toward the end of last year. Unfortunately the drop in the price of lead has since made it necessary to close the smelter for a time.—EDITOR.]

FOUR YEARS AS A PRISONER OF WAR

By J. C. FARRANT.

The author was taken prisoner after the fall of Antwerp, and was sent first to Döberitz, then to Russia, and afterwards to Saxony.

DURING the time I was in the hands of the Germans I kept a record of the life of the prisoners, the conditions under which we existed, and general treatment. On many occasions searches for notes and diaries were made by the German authorities, but they did not find mine. On one occasion a diary made by another prisoner was found when we were in the Russian trenches, with the result that the whole Company was punished by working an additional two hours daily for an indefinite period. This made our own men sore, and I was quite unpopular for the time because they knew I had a diary as well. As we were having a particularly sticky time, I almost decided to destroy my notes, but on second thoughts I did not.

On the morning of October 4, 1914, men of the Royal Naval Division at Walmer marched to Dover and embarked for Dunkirk, arriving there the following morning. We reached Antwerp early on the 6th, and marched to our positions. This affair has already been sufficiently discussed, but one fact, which is often overlooked, remains, namely, that the entire Belgian Army was enabled to retire. We changed our positions more than once during their retirement, and as we were under enemy aeroplane observation at different times, the enemy was bluffed as to the number of divisions we had in the trenches, for, after we were captured, the enemy inquired the location of the "other divisions."

We were captured at Exarde on the night of the 9th. From Saturday, the 3rd, until the 10th, I had only eight hours sleep, and up to the time of our capture had marched continuously for 24 hours. Half-an-hour after our capture we were marching, or I should say stumbling along with our eyes closed, for we were all in, when we were fired upon, presumably by a German picket. Our guards made a dive for the hedges on either side of the road. So did we, with disastrous results, as a German officer screamed out we were trying to escape, whereupon our guards opened up at point blank range or else used their bayonets. A man next to me was bayonetted, and was left, as were others, in the ditches. We never found out the cause of the first firing.

We arrived at a small church about 3 a.m. on the 10th, where we were interned. I shall never forget that church; in fact, I am going over to a service there, just by way of a contrast. Double guards were mounted in the pulpit, organ loft, and on the altar. We were crowded in any fashion. We were given a 1 lb. loaf between ten, and a cupful of soup on the following day. Ten men at a time were allowed to go to the latrine. Many men, as soon as they came in contact with the fresh air, rolled about like drunken men. There were about 1,000 all told, British and Belgians, in the church, and at night two pails were placed in the church for urinal purposes. Imagine it! 1,000 men and two pails. The men sleeping on the floor near the pails were very tired—and wet.

On October 12 we were formed up and marched to Termonde, the prisoners carrying the guards' packs. At mid-day we halted, the guards pulled up some swedes, which we ate ravenously. We reached Termonde about 1 p.m. It was razed to the ground, and along the route we took not one building was intact. While waiting at the railway siding, a German cook, who was operating a field cooker, hooked out a piece of meat, and held it out to one of our men, who, upon approaching, just dodged a welt from a soup ladle, while the meat was given to a Belgian, much to the amusement of some German officers standing by.

We entrained about 3 p.m. in cattle trucks. The Belgians had straw in theirs, and 20 men to a truck. We had 40 men, and no straw. A further distinction was made with the aid of chalk on the Belgian trucks, where someone had written "Belgien gut," "Francösen gut," aber "Englisch Schwein." We got under way about 4 p.m. At our first stopping place people crowded on the platform to see the "Englisch Schwein;" and the men and women were equally dexterous in expectorating at us. There were four guards to each cattle truck. They changed guards at Cologne, which we reached at midnight. One slice of war bread per man was given us; it tasted like angel cake to me.

The next morning we pulled up at a station and coffee was brought to the guards. We had had nothing to drink since the previous day, so we asked the Red Cross female attendant who brought the guards' coffee to give us some. She merely used the well-worn expression "schwein," and deliberately poured the remaining coffee on the platform. We were 60 hours on this train, during which time we had one soup meal and one slice of bread. It was too cold to sleep, and only some of the men could lie down at one time.

We reached Döberitz at 6 a.m. on October 15, all very cold. We were put into tents, three men on two mattresses, large rents in tents, and no fires. The tents, which held about 400 men, were erected on waste ground. The damp soon rotted the mattresses, which were filled with wood wool. The camp routine at this time was: Reveille 5.30 a.m., coffee 6 a.m., work 6.30 a.m., soup 12 a.m., work 1 p.m., coffee 6 p.m. Besides the soup and coffee we received half of a 3 lb. loaf per day.

At Döberitz there were two camps surrounded by barbed wire, and divided by a road. In Camp No. 1 there were 4,000 Mons men, who were captured in August. Lonsdale, whose history is well known, was among these. We were given blankets, bowl, and spoon. Our knives were taken from us, and we sharpened our spoon handles on stones in order to divide the bread. It was very cold. Most of the naval men only wore their flannels, having left their jerseys in their kit bags. Many of us tied blankets round our bodies, and then put our oilskins on top. It was rather an uncomfortable walking rig, but fairly warm. The work consisted of general labouring. Cleaning out refuse bins in the German barracks fell to my lot for a whole week. The guards were continually at us with "los," "arbeit," "immer fester," frequently punctuated with the butt of a rifle. A couple of our men, having been knocked about, reported the matter to a German sergeant major. His answer was to call up two or three guards, and order them to charge. This was just after Lonsdale had struck a German. Early in November the whole place was running alive with vermin. There were no baths, and only two taps on the parade ground for 4,000 men, some 3,000 Russians having joined us. I had a bath in my soup bowl out in the open. The operation was carried out in sections, and it was damned cold. In addition to the lice, a blood rash was coming out on every one, making it impossible to sleep. This was in November, and right on until March we remained in this condition, lousy, and covered with sores. Some men had scratched themselves raw, and were taken to hospital, where their hands were bandaged, and tied up so that they couldn't scratch. The chronic itching nearly drove us crazy.

Another ailment we all suffered from was weak bladders. Our diet was all liquid with the exception of bread, the result being that men would go to the latrines ten or twelve times in one night. The loss of sleep, poor food, and long working days, soon told its tale, and men were fainting at work daily. They were brought back on carts.

On November 22 I had a high temperature and was unable to get up, so I was carried down to the hospital on a stretcher. I still wore the same shirt that I was captured in. I had not had a shave or hair-cut for about two months, so I thought at last I should get a clean shirt; but there was nothing doing. I stayed in hospital a week, being medically examined daily. This place was running alive with vermin. I spent most of my time killing them off. Such was the German Prisoner of War hospital at Döberitz in 1914. I had tonsilitis, but before I was well I was ordered out to make room. I got up straight from bed, and walked back to the camp through the snow with a guard. It took me 25 minutes, though it was only ¼ mile from the lager.

While I was in hospital, Matthews, R.F.R., was shot. About 4,000 men were waiting to go through the gate to draw coffee. Those at the back pressed those in front on to the barbed wire. The sentry on the gate ordered the men to get further back. They tried, but, owing to the weight behind them, they were unable to move. The guard fired, killing Matthews, and wounding three others. Upon returning to camp I went to the sick tent, but as it leaked worse than my old one, I returned to the latter. I passed the time playing chess (home made) and bridge, one of the boys having brought some cards with him.

November 30. We moved into huts, similar to those occupied by the German troops, the difference being that we slept on the deck, three men on two mattresses. Each hut had a small lobby. The places were so crowded that some men had to sleep there—in December.

December 3. I heard from home, and wrote my second post card, asking for money, food, clothes, and tobacco, as I was still wearing the same shirt, and had tried tea leaves and oak-apple leaves in my pipe till my tongue was like a piece of leather.

December 4. I had my first hair-cut and shave, on the Q.T., as no knives or razors were allowed. The "barber" had found an old table knife while loading up rubbish. This he sharpened, and with it shaved several hundred men, most of them getting up with tears in their eyes after the operation.

December 6. The German corporal, generally known as the "pork butcher," made his appearance. This man was responsible for the greater part of the horrible brutality that took place in Döberitz. He spoke fluent English, and was supposed to have had a butcher's shop in England.

December 7. Burgoo was served for breakfast, but there was not enough to go round. When this was known, the remainder rushed the cook-house. A German sergeant held the men up at the end of a revolver. On this occasion there was no shooting.

December 8. Holtham, of the R.N.D., received a packet of Smith's Glasgow Mixture, and gave me a pipeful. Of all the pleasures I have had in my life, this was the greatest.

December 9. My throat was troublesome, so I went to hospital. Waited outside in snow for three hours. I had my throat painted on the inside with iodine; have you ever experienced this? Complaints were made about sick men waiting daily in the snow outside hospital.

December 12. All Roman Catholic Irish left camp. It is not known where they went. We were ordered to move into other huts, half Russians and half English in each hut. This was petty spite on the part of the Germans. We at least tried our best to keep comparatively clean, but the Russians made no attempt. The Russians closed all their windows, so we opened all ours. The Russians complained to commandant, who ordered the windows to be closed all night, true continental style. The place stunk, and the atmosphere was so thick one could hardly see across the room. So several windows on the English side were opened to a chorus of howls from the Russkis, of which scant notice was taken.

About 1 o'clock a.m., Poole, of the R.N.D., was lying awake, when a bowlful of ice-cold water was thrown over him, drenching him and his pal. Up they jumped, and spotted a Russki skudding across the snow. They noticed a vacant bed on the Russian side, so waited just inside the door. Presently in came a Russian. Bang! right in the mouth. The howls of the Russian woke every one up, and a general set-to ensued. The amusing part of it was that after quiet had been restored it was found to be the wrong Russian. However, he was easily appeased with a bowlful of soup on the following day, and he became Poole's batman subsequently. The actual perpetrator of the deed was never found.

Parcels for prisoners of war began to arrive, though mostly clothes.

The men were paraded every morning and marched out in parties for work. "Dodging the column" was frequently practised, as the system in vogue at this time was pretty slack.

The "pork butcher" was in charge of our block, No. 8. His style of punishment for minor offences consisted of tying men to posts on tip-toe with their hands above their heads. After a time the pain was excruciating. The time given was from two to six hours, but with the longer periods the hands were not tied above the heads. Many men fainted on the two-hour spasm. Men who had undergone the punishment have also complained to the British authorities. Among them may be mentioned J. Rudram, Poole, and Greenwood, of the R.N.D. Rudram, whom I have just visited at Yarmouth, still suffers from the result of being tied up on one leg for "dodging the column." He is a North Sea fisherman of a particularly rugged type, and his undying wish is to meet the "pork butcher" on these shores. He is not the only man holding this wish.

On the last day of 1914 at 9 p.m. every man was solemnly sitting up in bed "killing off," which operation was conducted twice daily, morning and night. Scratching was also much in vogue. We told Kirk, the only man with a watch, to call us at 12 p.m. This he did, and we sang God Save the King, Rule Britannia, Auld Lang Syne, and we were just giving the Marseillaise and Hail Columbia, when a rifle was thrust through the window, with the guttural command, Ruhig!

The year 1915 opened with bad weather. The parade ground was ankle deep in mud, and there was only one latrine open with an accommodation for 18 men. As there were 9,000 of us, men had waited "on ranko" for hours. This disgraceful condition of affairs continued for three days, and it was then decided to dig open latrines in one corner of the parade ground. Even these were inadequate.

January 4. It was pitch dark, and to avoid the general rush for coffee, I took a short cut over forbidden ground. I walked straight into a German sentry. He let drive at me with his butt end and knocked my wind out. Another guard came out, and they asked my name, and what I was doing there. My answer was to take full advantage of the darkness.

The food was getting worse. The bread was wet and soggy, and of a dark brown colour. The word "Gefangenen" was moulded on each loaf. The bread was green on the outside. This had to be cut off, thus diminishing our ration, which was further reduced on January 28 to one 3 lb. loaf between four men. Breakfast consisted at this period of $1\frac{1}{2}$ pts. of skilly, very thin. The midday soup was mainly cabbage water, with occasionally a potato if the cook dipped deep enough. Swedes, horse carrots, horse beans, and salt fish were on the menu on different days, always in soup form. Sauerkraut with carraway seeds was occasionally dished out. I am not a squeamish individual, but that slush used to kill my pig. A drink only was issued at night.

There were eight blocks at Döberitz, each block having its own galley. There were roughly 1,000 men to a block. We paraded daily under German N.C.O.'s attached to each block, the whole parade being in charge of a feldwebel, who was a typical Prussian bully. Generally speaking, our worst enemy was the dolmetscher (interpreter), or "dollsmasher" as the boys called him. There was one interpreter to each block.

We had two electric lights in each hut; only those directly under the lights could see to read. Half a pailful of coal a day was allowed for each hut. It usually lasted about three hours. No firewood was supplied, the boys bringing sticks in from work. Of course a good deal of wood was half-hitched from the lager. More than one pole to which men were tied up for punishment disappeared into the stoves. These poles were situated near the barbed wire fence, and under observation of the sentries round the camp. One of the favourite ruses was to start a sham fight by the sentry, while two other men did the necessary.

January 15. A Russian found selling chocolate in the camp was tied up three hours daily for a week. A Tommy received the same for stealing some sausage. One working party was told off to sharpen bayonets; they refused.

Parcels from England were now making their appearance, and camp life improved immensely in consequence. Men began to repair their clothes and smarten up generally, although no bath had fallen to our lot, the Russians going through first. Football was played on the square, and cards in the evening, while the "Crown and Anchor" boards were attracting their usual numbers. Pontoon was the favourite card game; brag, nap, and solo were good seconds, only a few indulging in bridge.

Smoking in the huts was "streng verboten." How that word riled us. Everything was verboten at one time or another, except work, and there was always bags of that. Needless to say, we always did smoke in the huts, the unfortunates who were caught being tied up.

January 26. The usual scrap round the tap in the wash house. A Russian and an Englishman mixed it. The Russian's eye was cut. He reported the Englishman, who was marched to the guard house under escort, the guards banging him in the back with their rifles.

Men who wished to report sick were paraded separately. The "pork butcher" himself inspected these men before allowing them to see the doctor. This man had no medical knowledge, with the result that many men were compelled to work in an unfit state, as he always weeded out what seemed to him the minor cases, who were thereupon detailed for work. The sick still waited about in the snow before receiving medical attention.

February 4. One of our men died ten minutes after he was admitted to hospital. He had been sleeping in the lobby, and had contracted double pneumonia.

February 9. A new gate was made for the entrance of the German staff building, and was left leaning against the fence. As firewood was urgently required, for it was very cold, the gate was taken to an adjacent hut and quickly broken up and put into the stoves. As the authorities were unable to find the man who stole the gate, the whole Company had to stand to attention for some time and were not allowed soup for that day.

February 13. I had my first real bath since leaving England four months before; it was great!

The routine in camp was pretty monotonous, daily working parties in all weathers. The men's boots were in poor shape. Wooden clogs were all that were offered by the Germans. These were certainly warm, but they raised the devil with our feet. There was no place to dry our clothes when wet. They were hung up on strings stretched across the hut, and very often we went to work in wet clobber.

February 24. The "pork butcher" became busy again, rounding up men who had dodged fatigue. Those caught were tied up with their hands above their heads for two hours. Poole, of the R.N.D., was one of them.

The new routine was: Reveille 5 a.m., coffee 5.30 a.m., parade 6 a.m. Parties worked from 6.30 a.m. to 4 p.m., and then came in for soup. During this time no meal was issued by the Germans. A man was supposed to work all day on $\frac{1}{2}$ lb. of war bread. Fortunately the parcels helped us out, and the spirits of every one were improving.

(To be continued).

A SMALL HYDRO-ELECTRIC INSTALLATION

By E. P. HOLLIS, A.M.I.E.E., M.Amer.I.E.E.

THERE are throughout the world in proximity to mines and other industrial organizations large numbers of small waterfalls which at the cost of little labour and money could be turned to account for producing power. The big waterfall attracts attention, but as a rule water-power in small quantities is usually neglected. In many parts of the United States where farmers require power for lighting their farms and driving their agricultural machinery, small falls are used in this way. In all parts of the world mines could obtain power supplies on a small scale in this way, and at very low cost, especially nowadays when fuel is so expensive. Moreover, water-power plant is particularly successful because it requires no skilled attention.

As an example of what can be done in this way, I will describe a plant recently laid down in Yorkshire. A firm of manufacturers had available on their ground a number of springs, and they decided to utilize the energy existing in these springs to drive their mill. The owners of the mill naturally did not desire to have any plant which called for expert attention, and they specified that it was to be entirely automatic and self-governing, that it must be started and stopped from the mill, that the speed was to be kept constant under all conditions to ensure a steady drive, and that it must not be necessary for an attendant to pay more than one visit per day to the power-house. These conditions were amply fulfilled by the contractors to whom the work was en-

FIG. 1. VIEW OF THE POWER HOUSE AND TRANSMISSION LINES.

trusted, and no better evidence of the steadiness of the governing can be obtained than on examination of the tachometer and pressure-gauges illustrated in the picture showing the interior of the power-house.

The first portion of the work was the building of a reservoir with a capacity of 6,000,000 gallons. This is fed by the springs, some of which rise 1,500 ft. above sea-level. The water collected in the reservoir passes through 9 in. cast-iron pipes to the power house which lies three-quarters of a mile away and 500 ft. below. The exterior of the power-house is shown in Fig. 1. The generating plant consists of a small tangential wheel of the Pelton type running at 600 r.p.m., being coupled to a 68 kw. continuous-current dynamo. The whole unit is shown in Fig. 2. The speed control of the turbine is obtained by a patent governor of which the head is mounted direct on to the shaft, thereby avoiding the use of chains or bolts for driving, and eliminating any possible chance of the set running away through the breaking of the intervening mechanism. There are no rotating parts on the governor so that there is nothing to heat or seize, nor are there any oil pumps, moving pistons, or cylinders, and the result is that whereas by means of an ordinary governor the water is shut off in from three to five seconds in case of an accident, in the installation described the water can be cut off in a fraction of a second without any shock on the pipe-line.

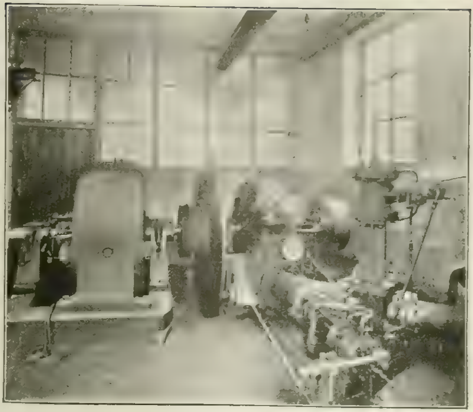


FIG 2. INTERIOR OF THE POWER HOUSE.

The governing proper is effected by means of deflectors. The simple deflector would use the full quantity of water on all loads and would waste that which was not required. In the deflector installed, the spear is inserted into the nozzle and controls the quantity of water flowing into the wheel. The motion of the spear is slow in order to avoid shock on the line, while in coming out the motion is very rapid when the load is thrown on. It was found on tests with full load thrown off, the momentary speed variation was but 1% above the normal, while the permanent speed variation between full load and no load was one-half of 1% above and below normal.

The entire unit is controlled by a remote control system from the mill, the controlling device comprising a hydraulic cylinder, the supply of water to which is controlled by a solenoid operating a four-way valve. The magnets are controlled through overhead wires by a switch at the mill, the energizing current for the magnets being taken from a battery of accumulators, otherwise of course there would be no power for operating them when the generator was shut down.

In order to avoid shocks on the pipe-line, the speed of travel of the vane can be accurately adjusted so that the complete travel can be made in anything from one second to five minutes. The transmission line, which is seen in Fig. 1, is simply constructed, the conductors being carried on wooden poles to the mill. The same poles carry the starting and stopping gear wires as well as the lighting and telephone wires. The conductors are cradled at points where the overhead line passes over public paths. Lightning arresters are installed at each end of the line. Being in a hilly district, the overhead line is particularly susceptible to lightning charges.

The mill plant is driven by a 70 h.p. motor running at a speed of 630 r.p.m., the motor being installed in a central motor house and driving the shafting through a silent chain running in an oil bath. The ratio of the transmission between the motor and the mill shafting is five to one. In view of the fact that the motor operates at 500 volts, this pressure being more economical for transmission, a small lighting dynamo is driven from the mill shafting producing a current of 200 volts. The generator is compounded, so that the mill voltage is maintained constant at all loads.

AUSTRALIAN IRON ORE RESOURCES.

Information from official sources is given herewith relating to certain iron ore deposits in West Australia, New South Wales, and Tasmania.

THE development of their mineral resources is being studied keenly by Australians nowadays, with the object of making the island continent self-supporting as far as possible. As regards an iron and steel industry, the Broken Hill Proprietary led the way by the utilization of the Iron Knob deposits in South Australia and the erection of a steel works at Newcastle, New South Wales. The Queensland Government has been active in its inquiries into the possibility of establishing a steel industry. In New South Wales, as recorded by the Magazine's Melbourne correspondent in the February issue, the firm of Hoskins is beginning to mine the Cadia iron ore deposits. The Federal Government has taken steps toward the acquisition of the Blythe River iron mines, which belong to the London, Australian, & General Exploration Co., Messrs. Bewick, Moreing & Co.'s finance company. In West Australia there are many important iron ore deposits, though, owing to their present economic isolation, little is heard of them ; but no one can tell when their time will arrive.

As the demand for information relating to the Australian iron ore deposits is considerable, it is appropriate to quote in these pages the official reports prepared by the members of the Geological Surveys of the several States. The report on the New South Wales deposits was made by Messrs. E. F. Pittman and J. B. Jaquet, that on the Tasmanian deposits by Mr. W. H. Twelvetrees and that on the West Australian deposits by Messrs. A. Gibb Maitland and A. Montgomery. These reports have been published as Memoirs by the State Geological Surveys, and also in the volume "The Iron Ore Resources of the World," prepared by the Stockholm International Geological Congress. Brief reports have also been given in the "Sources and Production of Iron and other Metalliferous Ores" issued by the Department of Scientific and Industrial Research.

West Australia.

Although the iron deposits of West Australia are probably some of the largest in the world, they have, up to the present time, remained absolutely undeveloped, and this is owing entirely to their geographical position and to the non-discovery of suitable coalfields in the State. So far the only iron worked at all has been that required for use as a flux in copper and lead smelting, and this has been obtained principally from small lateritic deposits handy to the smelters.

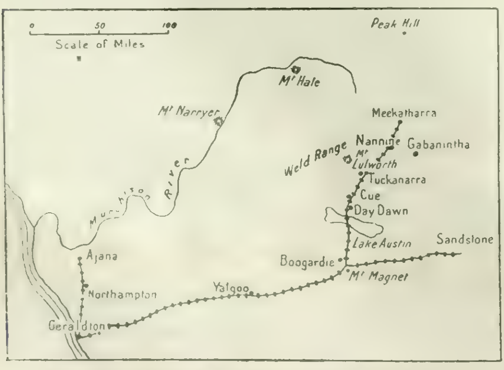
Broadly speaking, the iron deposits of West Australia fall into two main classes:

(*1*) The ores associated with the crystalline schists and other allied rocks.

(*2*) The superficial deposits of limonite (laterite ore), which occupy extensive areas in many and widely separated portions of the State, and the soft porous deposits of bog ore of comparatively recent origin.

The ores of Class (1) are by far the most important. They are most largely developed in the Murchison district, and the chief deposits are those at the Wilgi Mia (Weld Range), Mounts Hale, Taylor, and Matthews, and Gabanintha. In addition to these places, however, iron-bearing schists are found almost all over the Murchison goldfields, and at numerous centres in the Pilbara, Peak Hill, East Murchison, Mt. Margaret, North Coolgardie, and Yilgarn goldfields, in fact, over almost the entire length and breadth of the State.

These deposits consist of highly inclined beds, bands, and lenses of almost pure hematite, magnetite, or admixtures in all proportions of hematite and quartz, usually laminated, and are the result of the chemical



Map showing position of Iron Ore Deposits in West Australia.

alteration of highly foliated and crushed belts of greenstone. They — especially the more silicious bands—not infrequently have a width of as much as 10 chains, the average being from half to one chain, and can be followed across country often for many miles.

WILGI MIA.—The Wilgi Mia in Murchison goldfield is situated about five miles to the east of the Weld Hercules gold mine, and two miles south-west of Mt. Lulworth, on a ridge running east and west along the south side of the Weld Range. The deposit, which is of almost pure hematite, is 150 to 200 ft. in width, and forms a ridge about three miles in length, rising in places to a height of 400 ft. above the surrounding plain. It is of similar origin to the hematite-bearing quartz lodes which form the main axis of the Weld Range, and which are so prevalent throughout the whole of the Murchison goldfield, the only difference being that in this case silica is almost entirely absent, and the lode is composed of almost pure hematite, with magnetite and limonite, resulting from the gradual replacement of greenstone schists by iron-bearing solutions.

The dip of the lode is nearly vertical. As sulphides are not likely to be met with above water-level, which is about 60 ft. below the surface of the plain, it can readily be seen that there is an immense body of ore here; the amount of ore actually in sight above the level of the plain has been roughly estimated at from 26 to 27 million tons.

In addition to this deposit, there is said to be a second similar though smaller one about two miles to the north-east of Mt. Lulworth. Samples of ore from here appeared to be about the same quality as those obtained from the Wilgi Mia.

These deposits, which are undoubtedly some of the richest in the world, are at present rendered practically valueless owing to their inaccessibility and distance from a suitable coalfield.

In Table I at the top of the next column are partial analyses of three samples of iron ore from the Wilgi Mia deposit, and also one of a sample of the hematite-bearing quartz from the Weld Range.

Traces only of titanium were present.

No. 1 is from what is known as the Little Wilgi Mia, about one and a half miles west of the Wilgi Mia, and on the same lode; it represents a sample taken across about 20 ft. of the lode at a depth of 15 ft. from the surface.

No. 2 is from the Wilgi Mia, and is representative of a sample taken across a face of the lode about 150 ft. in width, and at a depth of 100 ft. from the surface (that is, from the top of the ridge).

TABLE I ANALYSES OF IRON ORES FROM WELD RANGE

No	Metallic Iron	Silica	Phosphorus %	Sulphur	Water (hygroscopic) %	Water (combined) %
1	[illegible]	2·48	[illegible]	0·033	0·89	1·52
2	64·3[illegible]	[illegible]	0·052	0·023	0·57	0·60
3	[illegible]	1·00	Trace	0·035	0·19	0·35
4	[illegible]·50	4·[illegible]	[illegible]	0·036	0·15	0·17

No. 3 is a picked sample of ore from a surface boulder at the Wilgi Mia; there are, however, a good many thousand tons of this class of ore lying on the surface.

No. 4 is a typical sample of the hematite-bearing quartz lodes which traverse the Weld Range from end to end, and is from a spot about three-quarters of a mile west of the Weld Hercules gold mine.

It will be seen from the above table that the ore from the Wilgi Mia deposit is of exceedingly high grade, extremely low in sulphur and silica contents, low in phosphorus, and free from titanium.

In addition to this high-grade deposit, there are the hematite-quartz lodes of the Weld Range, of which No. 4 is a typical example. These, which are in practically inexhaustible quantity, though of rather too low grade for smelting purposes as they now exist, could, with the employment of suitable concentrating machinery, be converted into first-class ores, and during this process of concentration would doubtless lose a considerable proportion of their phosphorus contents. These remarks also apply to the hematite-bearing quartz lodes, which are found in such quantities over the greater portion of the State, of which a typical series of analyses is given in Table II on the next page.

With regard to the probability of these deposits living to a depth, it may be mentioned that at several places on the Murchison they (the hematite-quartzite lodes) have been proved at a vertical depth of over 250 ft. with apparently no change in their mineral constitution beyond a slightly increased sulphur percentage.

MOUNTS TAYLOR, HALE, AND MATTHEWS.—The sigma-shaped range of hills on the west side of the Murchison, of which Mts. Taylor, Hale, Matthews, and Yarrameedie form the most prominent points, is remarkably prolific in iron-bearing schists. The summit of Mt. Hale is formed of contorted quartz schists, with bands of hematite that occur in lenticular masses. Some bands are often as thin as a sheet of paper, while others widen out to con-

TABLE II.—RESULTS OF PARTIAL ANALYSES OF A SERIES OF SPECIMENS OF HEMATITE-BEARING QUARTZ.

Locality	District	Metallic Iron	Silica	Phosphorus	Sulphur	Water (hygro.)	Water (combined)
		%	%	%	%	%	%
Lake Austin	Murchison	39·65	38·42	0·068	0·042	0·12	4·03
Do.	Do.	42·11	36·38	10·06	0·054	0·14	2·49
Tuckanarra	Do.	40·55	36·64	0·02	0·02	0·07	4·13
Do.	Do.	38·15	38·54	0·20	0·03	0·17	3·75
Quinn's	Do.	29·63	54·15	0·073	0·034	0·08	0·60
Nannine	Do	31·28	47·48	0·312	0·030	0·28	3·89
Boogardie	Do	50·55	34·26	0·042	0·029	0·41	2·94
Do	Do	32·83	52·50	0·072	0·017	0·08	1·33
Do	Do.	26·63	61·13	0·028	0·019	0·07	0·66
Edjudina	N. Coolgardie	37·38	45·05	0·04	0·032	0·17	0·49
Do	Do.	25·86	60·82	0·04	0·026	0·12	0·87
Do	Do.	26·69	59·55	0·03	0·038	0·05	0·74
Do	Do.	33·45	51·76	0·04	0·034	0·11	1·08
Do	Do	38·33	43·10	0·06	0·024	0·12	0·93
Do	Do.	22·85	61·19	0·08	0·036	0·23	4·24
Southern Cross	Yilgarn	33·67	50·12	0·072	0·087	0·03	0·50
Do	Do.	37·04	41·55	0·187	0·064	0·26	3·37
Parker's Range*	Do.	60·38	2·93	0·038	0·066	0·44	9·12

* This sample is from the top of Mount Cordan where there is a fair sized deposit of high-grade ore, as well as a large quantity of the lower grade, more silicious variety.

siderable dimensions. One band measures 70 ft. across and outcrops for over a quarter of a mile; it varies somewhat in thickness, however, in different parts. There are other similar parallel bands equally persistent along the strike.

Just under the western summit of Mt. Hale the quartzite is replaced by a great bed of hematite, several huge monoliths of which stand out prominently on the range. This bed can be followed along the range to a point just south of the summit of Mt. Matthews. An assay of a grab sample of this deposit gave a result of 66·6% of metallic iron.

MOUNT NARRYER.—The outcrop of a bed of ironstone forms a conspicuous feature on the surface at the foot of Mt. Narryer Range. This bed is 8 to 9 ft. in thickness, and rises 2 to 3 ft. above the ground. Numerous other similar parallel beds also occur along the range. An assay of a typical sample of one of these gave results equal to 56·7% of metallic iron.

GABANINTHA.—About half way between Gabanintha and Star of the East is an extensive deposit of iron ore. In its mode of occurrence this deposit is similar to that at the Wilgi Mia, and to the hematite-quartz lodes described before. The lode forms a low ridge running nearly north and south for a distance of about 2½ miles, and having an average height of 30 or 40 ft. Its thickness varies from 50 to 100 ft., often more, and a very conservative estimate has put the amount of ore actually in sight above the level of the plain as over one and a half million tons. The ore consists of hematite and magnetite, carrying a considerable percentage of titanic acid. A partial analysis of a typical sample shows its composition to be as follows: Metallic iron, 52·14%; silica, 0·20%; phosphorus, 0·008%; sulphur, 0; titanic oxide, 12·68%; water (total), 1·30%.

DISTANCES TO RAIL AND SEA.—The following table shows the position of the principal Murchison deposits with reference to the nearest railway station, and nearest seaport connected therewith:

Deposit	Total distance from seaport. Geraldton Miles	Distance from railway Miles
Wilgi Mia	302	40, Cue
Mt. Hale	390	80, Nannine
Mt. Narryer	362	100, Cue
Gabanintha	330	20, Nannine

TASMANIA.

The most important iron ore deposit in Tasmania is the Blythe River iron ore deposit, situated near the Blythe River, in the north-western part of the island, about 6½ miles from the coast. In addition, there are several smaller deposits, partly within the Dial range in the north-western part, partly in the district of Beaconsfield and Salisbury, in the north-eastern part of the island.

BLYTHE RIVER DEPOSIT.—In a rocky ground, consisting of Cambro-Silurian slates and sandstones with almost vertical dip, the ore appears as a conformably embedded layer of hematite of varying quality, with a known length of 5,940 ft. The outcrop runs up a hill on either side in a series of huge crags, which contain, as a rule, massive crystalline ore and have therefore had more resisting power against weathering than the poorer parts of the deposit. In the southern part of the deposit 40 to 50 ft. east of the main outcrop have been trenched upon a parallel ore bed of more silicious material. For a distance of 21 to 47 chains northward from the river and at a height of 600 ft. above the same, the deposit is covered by a basalt, rich in olivine, the greatest thickness of which, above the ore, amounts to 120 ft.

In the southern part the deposit has its greatest thickness. At $2\frac{1}{2}$ chains south-west from the river and 200 ft. above the stream the outcrop measures 4 chains across. For half this distance there is good ore; the rest is seamy and, toward the foot-wall, more silicious. At $4\frac{1}{2}$ chains south-west of the river the ore bed measures 147 ft. across. At 9 chains south-west of the river is, what is called, the "purple crag," an immense projecting mass of solid ore. Here the ore is exposed to a width of 114 ft., but it evidently continues to the west, concealing below overburden, getting silicious also in that direction.

For the purpose of proving the deposit three tunnels have been driven: the lower tunnel, at the northern side of the river, parallel with the foot-wall of the ore: the central tunnel at $8\frac{1}{2}$ chains north of the river and 280 ft. above the river level; and the upper tunnel at 53 chains north of the river and 650 ft. above the same.

From the lower tunnel, which has been driven to a length of 225 ft., seven cross-cuts have been made into the ore at the respective distances of 30, 45, 66, 77, 142, 167, and 225 ft. from the opening. These cross-cuts have disclosed good payable ore, though it is here and there not without silicious matter. In no instance has a cross-cut been driven right across the ore-body and, therefore, absolute evidence as to the thickness of the ore at that depth is wanting. But there is apparently no reason for questioning that the thickness of the outcrop is maintained down to the level of the tunnel. At 6 chains north of the river the outcrop measures 81 ft. across. It contracts to 30 ft. at the river. The vertical depth of the cross-cut at 30 ft. is 36 ft.; at 45 ft., 42 ft.; at 66 ft., 52 ft.; at 77 ft., 57 ft.; at 142 ft., 96 ft.; at 167 ft., 111 ft.; and at 225 ft., 140 ft.

The central tunnel has been driven right through the ore bed 50 ft. below its outcrop. The latter is stony to soft, and is rather a poor-looking part of the line, between two large crags of ore, which project from the surface of this side of the hill. The ore deposit in this tunnel measures 54 ft. across and is of inferior grade. Perhaps 10% is good ore; the rest is earthy and silicious.

The upper tunnel is a cross-cut tunnel too, cutting the ore-body at 79 ft. from the surface. The ore measures 94 ft. across at the surface, and in the tunnel 84 ft. The ore in the tunnel is good grade all through, barring a few silicious and earthy patches.

Table III. below gives some analyses from this deposit.

To furnish a rough idea of the extent of the deposit Mr. Twelvetrees estimates the quantity of marketable ore existing above the level of the river at 23,000,000 tons. He bases his

Table III. [illegible] the River Ores.

	Iron %	Silica %	Phosphorus %	Sulphur
From the lower tunnel				
Cross-cut at 66 ft.	46.0	34.2	—	
" " 77 "	65.0	7.[illegible]		
" " 142 "	67.2	[illegible]		
" " 167 "	68.1	[illegible]		
" " 1[illegible]9 "	6[illegible].5	[illegible]		
" " 225 "	6[illegible].7	1.6	[illegible]	[illegible]
From the upper tunnel	[illegible]9.[illegible]	14.[illegible]		
Upper quarry	6[illegible].4	2.2	[illegible]	Traces
Central tunnel	56.[illegible]	1[illegible].[illegible]		—
Lower south crag	61.5	1.[illegible]		
Purple cliff	68.6	1.8	0.09	Traces

calculation on a mean specific gravity of 4·75 and makes a deduction of 33% for waste rock

NEW SOUTH WALES.

On account of its extent, quality, and relative proximity to coal and limestone the iron ore deposits at Carcoar and Cadia are regarded as the most important in New South Wales. These two places are distant from one another only fifteen miles, and the ore occurs in a belt of Ordovician rocks extending between them. These rocks comprise clay-slates and shales, argillaceous sandstones, and breccias. They are much folded and contorted, and interstratified with them are sheets of augite-hornblende andesite.

CARCOAR.—The ore occurs at a point about $2\frac{1}{2}$ miles from Carcoar in a southerly direction. It is from this deposit that the iron ore has been obtained for some time for the iron smelting works of G. & C. Hoskins, Limited, of Lithgow. In all, thirteen distinct outcrops of ore have been noted. All the outcrops appear to be conformable with Ordovician slates, which have a general north and south strike, and dip at a high angle. Some outcrops belong to distinct bodies of ore, but others are undoubtedly connected together beneath the surface. For instance, three small outcrops occur between two large ones. These outcrops form part of one great ore-body which, over a considerable area, is hidden from view by a deep deposit of soil. Again, it is probable that this ore-body extends northward under the gravels of the Coombing rivulet, and that other outcrops form part of it. Two outcrops appear to belong to separate beds, which run parallel to the main bed of ore.

The dimensions of the various outcrops are as follows:

	Greatest length in feet	Greatest breadth in feet
A	132	53
B	66	40
C	33	20
D	33	20
E	66	40
F	1,122	310
G	66	20
H	[illegible]	33
I	[illegible]	26
J	[illegible]	330
K	79	33
L	660	3
M	528	16

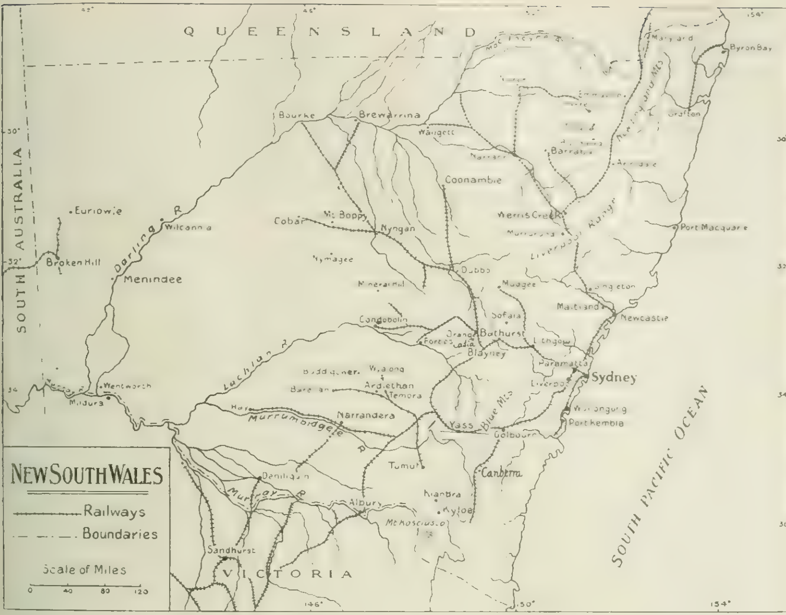
A quarry, with a face 40 ft. high, and several smaller quarries have been opened up on outcrop F, and under the direction of Mr. J. B. Jaquet a shaft was sunk to a depth of 100 ft. From the bottom of the shaft a cross-cut was driven for a distance of 160 ft. and a bed of ironstone 100 ft. thick encountered. The bed of ore dips with the country in a westerly direction.

The ore is compact, and possesses either a brown, reddish brown, or dull purple colour. That obtained from near the surface is frequently more or less ochreous. The great bulk of the ore appears to consist of hematite, with a small admixture of limonite. However, a considerable quantity of brown ore has been won from the quarry at the northern end of outcrop F, where it is associated with a cherty rock, which, though containing a high percentage of iron, is rejected from parcels of flux, on account of the silica contents being high. Near the shaft small quantities of friable magnetic ore of excellent quality have been found. Included bands of slate, which are not continuous over wide areas, are of common occurrence. All the ore contains more or less manganese, and small pockets of rich manganese ore have been met with in some of the quarries.

Mr. Jaquet estimates that the Carcoar iron ore contains on the average about 53% iron, 10% silica, and 0·09% phosphorus. In arriving at this estimate he gave particular regard to the bulk samples taken in the cross-cut across the deposit at a depth of 100 ft.

The main bed of ore is certainly not less than 3,168 ft. in length, and an average thickness of 80 ft. may justly be assumed; but to make allowance for including bands of slate this was reduced to 80 ft. In arriving at his estimate Mr. Jaquet states: "Now, in so far as the ore at 100 ft. has undergone no alteration—indeed on the whole I believe it is more compact and of better quality than that occurring on the surface—I think I am justified in taking 125 ft. as the depth for the purpose of my estimate. I propose to assume that the average weight of a cubic foot of ore is 224 lb.; the weight per cubic foot for three samples as determined by me being 225 lb., 245 lb., and 249 lb., respectively. In this way I estimate the ore in sight at 3,168,000 tons." The fact has again to be emphasized that this is an estimate of the ore actually in sight as disclosed by a very limited amount of prospecting, and there is every reason for believing that further explorations will prove the deposit capable of yielding many times this amount of ore.

CADIA.—At Cadia a bedded ore deposit outcrops in two localities, distant about $1\frac{1}{2}$ miles from one another, and about eleven miles from the western railway line at Millthorpe. One is upon the property of the Canoblas Copper Mining Company, and the other, known as the Iron Duke mine, upon the property of the Australian Mining Company.



Though occurring in rocks of similar age, these deposits differ materially from those at Carcoar, to which reference has just been made. At Cadia the sheets of andesite are thicker. They form the dominant rock of the district and enclose the beds of iron ore on all sides. The andesites are highly altered. Much of the augite has been changed into uralite, a considerable amount of chloritization has taken place, and the chlorite, in some instances, has been further altered into epidote and calcite. These changes are frequently accompanied by the production of magnetite, and in this circumstance is found a clue as to how the iron ore has originated.

On the Canoblas mine there are two large outcrops of ore, and one smaller one. One outcrop covers an area of 3·68 acres, and trends up a hillside for a distance of 900 ft., being finally lost to view under a sheet of basalt which caps the top of the hill. The stratification of the deposit is well shown at the waterfall in the creek, where the bed dips 15° in a north-easterly direction and has a thickness of about 60 ft. The second outcrop is 1,100 ft. long and extends over an area of four acres. In the absence of shafts or bore-holes, Mr. Jaquet was unable to say whether these two outcrops belong to distinct beds, but such is probably the case.

The Iron Duke mine is distant 1½ miles from the Canoblas in a west-north-west direction, and is very probably situated upon the same bed of ore. The ore is exposed for a length of 3,000 ft. and apparently has an average thickness of at least 80 ft. It dips at a low angle in a south-easterly direction. The outcrop covers an area of forty acres. It extends from a point a little east of Cadiangullong Creek, across to the other side, and from thence up the side of a steep hill until it reaches a height of over 400 ft. above the creek.

There are two classes of ore, oxidized (secondary) and unoxidized (primary) ore. The oxidized ore is composed of hematite (chiefly specular ore), with a little magnetite. It contains from 57 to 65% of iron, from 5 to 10% of silica, and from 0·013 to 0·051% of phosphorus. The ore originally contained a little pyrite, but has been desulphurized as the result of contact with the atmosphere, and a proportion of it, at any rate, contains appreciable quantities of copper. The latter metal has been rendered soluble, and removed by percolating waters. The unoxidized ore is only exposed at the surface in a few places, but it has also been encountered in some of the old copper workings. In this connection it is interesting to note that copper mines have been worked in the Cadia district, as recorded in the January issue of the Magazine. The specimens examined by Mr. Jaquet only differed essentially from the oxidized ore in containing carbonate of iron (siderite), a small quantity of iron pyrite, and occasionally some copper pyrite. It may be that the copper is mainly confined to certain parts of the bed, but this question cannot be satisfactorily answered until suitable exploratory work has been carried out. One sample yielded upon analysis over 10% of carbonic acid, so it probably contained over 20% of carbonate of iron.

As regards ore reserves, Mr. Jaquet states: "I am unable, in the absence of suitable shafts or bore-holes, to estimate the quantity of ore with any degree of accuracy. However, assuming the bed to be 80 ft. thick, and to extend into the earth for a distance of half the length of its outcrop, and that a cubic foot of ore weighs only 224 lb., we arrive at the following figures: Canoblas, 3,000,000 tons; Iron Duke, 36,000,000 tons."

The difficulty met with in discussing the value of these deposits is the question as to how much of the ore contains copper as to render it worthless as an iron ore, and what quantity is free from this objection. Since Mr. Jaquet's memoir was written further exploration in the way of a cross-cut at a depth of 30 ft. from the surface was carried across the ore-body in the Iron Duke mine. Average samples taken from the south and north sides of the cross-cut yielded as follows:

Average sample of ore exposed upon the walls of cross-cut south:

Water at 100 C	0·41
Iron	60·7[illegible]
Silica	9·[illegible]
Copper	0·01
Sulphur	0·035
Phosphorus	0·010
Carbon dioxide	0·024

Average sample of ore exposed upon walls of cross-cut north:

Water at 100 C	0·41
Iron	[illegible]
Silica	12·72
Copper	0·08
Sulphur	0·124
Phosphorus	0·022
Carbon dioxide	0·020

After examining this cross-cut and testing the ore encountered, Mr. Jaquet felt justified in stating that there are at least 4,000,000 tons of ore suitable for the manufacture of steel by the cheaper acid process in sight in this mine, and that it is possible, indeed probable, that further prospecting operations will prove the deposit capable of yielding 10,000,000 tons, or even a larger quantity of excellent ore, which could be cheaply won by quarrying.

NEWS LETTERS.

TORONTO.

February 8.

SUDBURY.—The International Nickel Co. has closed its Crean Hill mine, reducing its staff by 800 men. This action is due to the fall in the demand for base metals during the period of readjustment. This enables the company to carry out a policy for some time in contemplation, but postponed during the war, of drawing all its supplies of ore from the rich deposits of the Creighton mine. The equipment of the Creighton has been greatly increased during the last few years, and production will for the present be limited to its output.

PORCUPINE.—The labour question is in a fair way of solution, as the influx of men released from the munition factories has latterly been augmented by the arrival of miners released owing to the curtailment of operations at Sudbury. But the lack of house accommodation is a serious drawback. There is a great deficiency of dwelling houses, and until this is remedied, the companies will not be able to increase their forces to anything like the extent desired. The Hollinger Consolidated, which now employs some 1,200 men and requires 1,000 more to work its plant to capacity, is arranging to build about 50 houses, which will only go a short way toward improving conditions. Official figures of the Dome Mines show 1,950,000 tons of proved ore with an average gold content of $5·10 per ton, the total value being $9,945,000. These figures only include the ore reserves between the surface and the 700 ft. level, below which work has been carried to a depth of 1,245 ft. and a number of ore-bodies cut of a higher grade than the ore of the upper levels. The present proved ore reserves are four years ahead of mill requirements. Vice-president C. D. Keading recently stated that present conditions did not warrant the immediate resumption of milling, but were improving rapidly. The option held by the McIntyre on the Plenaurum property, which recently expired, has been extended for another 12 months. At the annual meeting of the Porcupine Crown the financial statement showed production valued at $105,247, with a net profit of $4,814. President Sir John Carson announced that active operations would be resumed.

The annual report of the Hollinger Consolidated shows a recovery during 1918 of gold to the value of $5,752,370 from the treatment of 578,755 tons of ore, as compared with $4,261,938 from 601,854 tons in 1917. Net earnings were $2,588,562, compared with $1,720,314 in 1917. Dividends were paid to the amount of $1,230,000 and $1,358,563 added to the surplus. The company holds government and municipal securities to the amount of $1,687,717. The estimated gross value of the ore reserves at the end of the year was $41,080,005, as compared with $40,231,435. President N. A. Timmins, in his report, noted the improvement in the labour situation, expressing the hope that the company would soon be able to secure its quota of skilled men. The problem of increased housing accommodation was under consideration. He announced that the company had arranged for sending its bullion to the mint at Ottawa to be refined, instead of to the United States Assay Office, New York, as has hitherto been the practice.

KIRKLAND LAKE.—The Tough Oakes is now in a position to resume operations owing to the settlement of litigation. The shareholders have authorized the sale of the unissued shares of the company at a discount of not less than 55%. A vein discovered at depth by diamond-drilling on the Elliott-Kirkland is being opened up on the surface where it carries low gold contents. The December output of the Teck-Hughes established a new record. Some 2,035 tons of ore was treated with an average recovery of $10·12 per ton. A wide ore-body showing a width of 37 ft. at one point has been opened up for 400 ft. The Canadian-Kirkland, recently taken over by George Angus and the Drummond interests of Montreal, will be in active operation this month. The annual statement of the Lake Shore shows that during nine months the mill treated 14,948 tons of ore, with a recovery of $370,123, with profits of $234,978.

BOSTON CREEK.—This district is attracting increased attention from investors. The Mining Corporation of Canada has been examining the property of the Patricia Syndicate with a view to acquiring it. It has already produced a considerable tonnage of ore and if operated on a large scale should become an extensive producer. At the Cullen-Renaud the shaft is down 50 ft. on a continuance of the rich vein of the Miller Independence. As soon as diamond-drills can be obtained the property will be drilled to a great depth. As a result of surveying and sampling the consulting engineers of the Miller Independence have recommended development at lower levels. The shaft will be put down to 500 ft. with lateral work at the 300 ft. and 400 ft. levels.

COBALT.—A considerable stimulus has been given to silver production by the marked decrease in the cost of supplies and material and the greater efficiency of labour. The mines have now all the labour required, and it is possible to utilize large tonnages of ore, formerly classed as waste, which can now be treated profitably. The Nipissing during December mined ore of an estimated value of $254,118 and shipped products from Nipissing and custom ore of an estimated net value of $687,285. The financial statement as of January 2 shows cash and ore on hand and at smelters to the amount of $3,898,711. The Nipissing has taken an option on the Ophir and is now operating the mine. The Crown Reserve appears to have secured a new lease of life. It is developing high-grade ore from the new vein opened up at the 200 ft. level, which has been driven on for 150 ft., showing an average width of 3 in. of ore averaging 2,500 oz. to the ton. Several other veins have been cut, one of which promises to be important. The Peterson Lake is issuing 100,000 preferred shares at par to raise funds for further development. The Temiskaming has arranged for the purchase of the Dolly Varden and Wolfe silver mines in British Columbia for $900,000. The annual statement shows earnings of $425,014 and profits to the amount of $135,394. The Kerr Lake during December produced 102,289 oz. of silver, which shows a considerable falling off as compared with the average for the year. At the McKinley-Darragh a new high-grade vein 1 to 4 in. wide has been cut at the 300 ft. level. The wall-rock also contains much low-grade ore. The output of the Coniagas for the year ended October was 974,264 oz. as compared with 1,344,267 oz. for the preceding year. The profits were $470,164. President R. W. Leonard stated that no new discoveries of importance had been made, and that the future of the mine depended mainly on the concentration of low-grade ore of which there was probably a three-years supply available.

NORTH OF ENGLAND.

LEAD.—The situation of the lead and zinc mines has not improved since my last communication, and things seem to be working up to a rather deplorable crisis. The price of pig lead has gone from bad to worse, and is now in the neighbourhood of the pre-war average (1914). For some years, the price of this metal had been already rising: 1910, £13; 1911, £14; 1912, £18; 1913, £18. 6s. 2d.; 1914, £18. 13s. 9d. It is difficult to estimate the world's present production, but from 1907 to 1913 there was an increased tonnage of about 13%, and from 1909 to 1914 an increased price of 43%. Lead is one of the few metals the output of which was expanding, but slowly, before the war, partly due of course to the Mexican revolutions. The conditions in Mexico are improving rapidly, and we may expect active competition from this source; but the reconstruction demands here must be enormous very shortly, and the present stocks of Government lead do not represent much more than the United Kingdom's demand before the war for four months. Looking forward, say nine months, there seems but little doubt that the whole stocks will be absorbed; and that we shall be dependent upon supplies from outside markets. Germany will be an active buyer, one presumes, and if I were a betting man I should make a shot at £35 as being a reasonable figure. What interests those managers whom I have seen is the present situation with the bottom out of the market, and the lead smelters demanding a largely increased "returning charge." Directly lead went up, the Government fixed the price, preventing all but a few mines from making a profit, and directly the price falls, the Government says the mines are a nuisance, and must not bother harassed officials who are busy clearing up their Departments.

Let me, however, try to explain the situation, with a view to showing that the Government has a real responsibility to the home producer of lead ore. If the ordinary economic laws of supply and demand were in operation, and the price of lead was too low to repay the cost of production, the extinction of the home producer might be defended by those who believe in the law of the "survival of the fittest." The Government has, however, made it part of its verbal policy to develop home industries, especially in raw materials. It is surely the duty of the Government to take every possible step toward this end, if the production of lead ore is of any real importance. The bonus on production, granted on a relatively small proportion of the output, is definitely cancelled on June 30, and from that date the lead and zinc mines are thrown to the winds. This bonus was given as a small recognition of the difference between the price the Government was paying to the home producer and those outside the United Kingdom. The public do not know what pig-lead costs the Government. I fancy that it is not put into warehouse under £30 per ton. This lead is sold to the consumer at the open market price in London for, say, £23, that is, the price at which the home producer has to sell his output. But compare the position of the foreigner. He sells his lead at, say, £35 to £40, which gives him a direct bonus from the British taxpayer of £12 to £17, and the taxpayer, who has invested in home mines, has to pay this, and the freight and administrative charges. The Government tells the mine owners they must carry out their legal obligations to the foreigner, but as the obligation to the British mines is merely moral, the Government is quite happy in repudiating it. The home production of lead ore (not pig lead) is roughly about 1,000 tons per month. The Government stocks increased in January by nearly 24,000 tons, probably representing an import of 28,000 tons, as some sales must have taken place. Using the smaller figure, and taking the cost at £45 in warehouse, and the price at which the Government is prepared to sell, that is, the present market price of say £23, we have subsidized the foreigner to the extent of well over £500,000 in one month. A home subsidy of £120,000, or £10 per ton, would preserve and stimulate the home mines for one whole year. In addition, foreign enterprise is developed, and when the home production is further reduced, the patient consumer at home will have to pay a higher price for his lead, owing to the elimination of one producer.

We now learn that the only Department with any acquaintance of home mines (the Mineral Resources Department) is being disbanded, and the work of years thrown away. This section of the Ministry certainly knew every mine and its condition; the cost of its staff must have been very small, and it has often been the only direct means of communication to the industry. It is really a crying scandal that it is not to be incorporated into either the Board of Trade or the Home Office.

ZINC.—In reference to blende, I can learn but little that would be of use to your readers. The situation is "wropt in mystery." We do know that the zinc market is to be thrown open, and the zinc subsidies stopped. The smelters assert that the present cost of producing zinc is near £25; with the metal at £38, and 2½ tons of blende required for a ton of zinc, a simple calculation will give the value of blende at the mine. The blende mines retain the output bonus until June 30, which will enable most of them to carry on until then.

THE OUTLOOK.—Personally I think that the Government should see the mines through the period during which it holds any considerable stock of metal. These inevitably depress the market, and render any stabilization of price impossible. In the meantime the Mine Owners' Association should be consulted, and all the facts of the situation disclosed to them, so that they may put up a good fight for the preservation of a potentially important industry.

When the Prime Minister's 500,000 cottages have been erected (that is, in two years) the amount of lead permanently absorbed will be very large. Then there is the painting and the enormous arrears of upkeep, which will use up gigantic quantities of lead and zinc oxides. On the whole the future is encouraging, and my good wishes go to the managers who are making such a gallant fight for life, in the whirlpool created by the dying flurry of the Department which has cast aside all interest in the industry, and reduced it to a very small factor in the national life.

MELBOURNE.

December 31.

NEW MINING LAW.—The Legislative Council of New South Wales has passed a new mining law which contains several important provisions dealing with the industry. The rent on gold and mineral leases of Crown lands is reduced from 5s. to 1s. per acre, but a royalty of 1% of the gross output must be paid. In order to encourage the miner in the developmental stages, an exemption of £500 is allowed before royalty becomes payable. This provision makes for uniformity, dredging leases and leases of private lands being subject to the payment of 1% royalty under the Act of 1906. The royalty on coal is now 6d. per ton on all coal, the previous allowance in respect of small coal being abolished. Lands held under all tenures under the Crown Lands Act, other than leases for pastoral purposes, are made private lands for the purposes of the Act, as such tenures are now convertible into freehold as the result of recent Crown lands legislation. Provision is made under which the Warden or Warden's Clerk can issue an interim authority to enter and prospect on private lands without any inquiry. The term of such authority is limited to one month, and the deposit required to cover rent and compensation for surface damage is 10s. Coal and shale are now made minerals for the purposes of Part IV. (mining on private lands) of the principal Act.

Lands alienated without reservation of minerals to the Crown (old grants and mining conditional purchases) are thrown open to the grant of authority to enter or lease to mine for minerals, subject to the payment of 5% of the net annual profits. This amount will be handed to the owner of the land, less 1%, which will be retained by the department to cover cost of administration. Protection is afforded to the owner of such lands who is mining or allowing any other person to mine on such land, and the owner is also entitled to rent at the rate of 20s. per acre for the surface occupied and to compensation for surface damage. The Governor is empowered to resume private lands required for the purpose of mining villages where no suitable Crown land is available in the vicinity of mining operations. Compensation is payable to the owner of the land resumed. All complaints as to non-fulfilment of labour conditions in respect of leases must now be lodged with the Minister, who will refer the same to the Warden to hold an inquiry on oath in open court. If the complaint is proved, the lease may be cancelled, and in such case the complainant is entitled to a lease of the cancelled area or any part thereof. Tailings left upon Crown or private land after the expiration of any lease under the old Acts (prior to 1906) will now become part of the land and subject to the grant of mining leases under this Act after the expiration of six months (Crown land), or twelve months (private land). Provision is made under which the Warden may declare mining titles other than leases forfeited upon proof that the land has not been worked for a continuous period of three months. Power is given to the Sludge Abatement Board to take evidence on oath. The Act contains a number of minor amendments designed to remove certain anomalies that experience in administering the Act of 1906 has shown to exist.

OIL IN PAPUA.—The want of success in connection with the Government oil-drilling operations in Papua is causing anxiety among the public. The Australian Minister for Home and Territories has, in reply to inquiries, given some imformation in the Federal House of Representatives with regard to the results obtained. Seven bores have been sunk. A rig has been erected for No. 8 bore, but, so far as is known, actual drilling has not yet commenced at the time of the last reports. Bore No. 1 was 242 ft. deep; No. 2, 133 ft.; No. 3, 460 ft.; No. 4, 302 ft.; No. 5, 395 ft.; No. 6, 580 ft.; No. 7, 1,800 ft. No. 1 met oil at 224 ft.; No. 2, gas only; No. 3, little oil at 320 ft.; No. 4, gas only; No. 5, small production of oil; No. 6, little oil struck at 182 ft. and 295 ft., but this was cased off, to enable the hole to be bored deeper; No. 7, oil struck at 185 ft., with a flow of 20 gallons per day; this was shut off to permit further testing at greater depths; large quantities of gas met with at 1,100 ft. The boring plants used on the first five bores were found to be quite unsuited for any depths over 300 ft., as the strata largely consisted of soft mud under considerable pressure, which filled the holes as fast as they were sunk. The bores consequently became choked and were abandoned. No. 5 was re-drilled. The oil horizon was isolated by cementing, and there was a small production, 100 gallons weekly, diminishing to 8 gallons weekly. The size of the casing was too small for further boring, and it was considered cheaper to bore a fresh hole. The mud pressure was very strong in No. 6, making work slow and costly. The plant in use was unsuitable for deep boring, and, in view of the mud difficulty, work was suspended. At No. 7 bore, efforts to get the 4 in. casing deeper than 1,700 ft. having ended persistently in failure, the work was stopped. This hole is several hundred feet deeper than the plant was designed to drill.

The total expenditure since the commencement of operations has been £96,150. This covers all outlay of every kind, salaries and wages, purchase of plants, purchase and operation of launch, repairs, insurance, construction of wharf, roads, and all travelling expenses. This last was an unusually heavy item, as men had to be brought from and sent back to the United States. Very substantial expenditure, in the way of leave of absence and medical attention, has been incurred owing to the unhealthy nature of the country. A large portion of this expenditure must be regarded as in the nature of general capital expenditure, and could not fairly be taken into account in estimating the cost at per foot of the bores already sunk. The result will be that the cost will show a gradually diminishing rate per foot. Very substantial reductions in boring costs have already been effected. The cost of boring in bores Nos. 6 and 7 ranges from £2 to £6 per foot.

The total expenditure before Dr. A. Wade undertook control was £38,187; and since then £57,963 About 2,000 gallons of oil have been produced. Considerable new plant has been purchased, and is now on the field about to be put in operation for the first time. Geological preliminary examinations have been made over about 2,000 square miles. More intensive geological examinations over 400 square miles, and complete surveys, including mapping, have been effected over 100 square miles, thus furnishing valuable data for future operations. The country was in an absolutely primeval condition; large clearings have been made in the forest, and all necessary buildings, including residences for the employees, stores, and workshops, have been constructed. It is to be hoped that future results will be an improvement on those already achieved.

ENGINEERING SOCIETIES.—There is a movement afoot for the federation or affiliation of all the engineering societies in Australia, with the object of creating a central institution that will efficiently represent the interests of engineers throughout the Commonwealth. The proposal was broached by Mr. D. F. J. Harricks in his presidential address to the Engineering Association of New South Wales. Twelve societies have been invited to discuss the question of co-operation. Of these, the Electrical Association of Australia, the Australasian Institute of Mining Engineers, and the Institute of Local Government Engineers cover the Commonwealth, while the Victorian Institute of Engineers, the Engineering Association of New South Wales, the South Australian Institute of Engineers, the Queensland Institute of Engineers, the Northern Institute of New South Wales, the West Australian Institute of Engineers, the Sydney University Engineering Society, the Melbourne University Engineering Society, and the Tasmanian Engineering Institute have more local interests. For some reason the executive committee of the Australian Institute of Mining Engineers has rejected the proposal. Many members consider this action inadvised and unduly precipitate, and are anxious that the general opinion of members shall be obtained. It is felt that the executive committee should not have taken up this attitude on their own initiative, but should have referred the matter to all the members of the society for their views on the subject.

CAMBORNE.

TINCROFT MINES.—The accounts of this company, always issued with commendable promptitude, show a gross profit of £731, but after allowing £1,648 for depreciation of plant and buildings, a loss is shown of £917. The gross profit compares with £14,954 earned for the preceding six months, and this very considerable change for the worse in the fortunes of the company is due mainly to increased working costs and reduced prices for its products, tin, arsenic, and wolfram. The working cost per ton milled, including royalties, but excluding depreciation, amounted to 44s. 9·61d. against 37s. 0·55d. for the previous half-year, and 21s. 3·32d. for the six months ended December 31, 1914. The tonnage milled shows a falling off of 2,700 tons, the quantity for this half-year being only 25,826 tons. This does not appear to be due to a reduced underground force, and one wonders if the labour efficiency is less. The production of tin concentrate was 175 tons, so that the produce for tin was only 15·2 lb. per ton milled. This low average is due to the fact that the upper levels are being worked principally for the benefit of their arsenic content. Arsenic to the value of £20,052 and wolfram £2,847 were sold. The development footage was 1,624, or approximately equal to 1 foot for every 16 tons milled. This development has been mainly directed to the opening up of the South lode. A sump winze sunk 100 feet below the 208 fathom level averaged 32 lb. black tin per ton over the depth sunk. Other winzes on the same lode give averages equal to or above the figure mentioned. It is proposed to connect up the sump winze on the South lode with Tyrie's shaft, which has now been cut down to a depth of 30 ft. below the 182 fm. level. This important connection when completed will much facilitate the handling of the ore in this section and thus reduce cost. There have also been fairly satisfactory developments on Pryce's lode in the old Tincroft section. The mine has clearly responded satisfactorily to the development of the past year or two, and it is very regrettable that the weak financial position has forced the management to the almost fatal policy of restriction of development. It is a thousand pities, when the company was doing well owing to the high prices being realized for its products, that the directors did not firmly press for the strengthening of its financial resources by the provision of additional capital; now, presumably, fresh capital cannot be attracted.

FUMES AS A PREVENTATIVE TO INFLUENZA.—From the report of Captain A. Gregor, R.A.M.C., to the Medical Research Board, it would appear that certain surface workers in our tin mines have one advantage, at any rate, over their fellow workers underground, which, while it cannot be translated into pounds, shillings, and pence, may compensate them for some of the disadvantages which they suffer. For some time past it has been noticed that men working in gaseous fumes are practically immune from nasal catarrh and respiratory diseases in general. Some interesting facts bearing on this subject are recorded in the report referred to on the epidemiology of influenza among those who work in fumes, and one of the illustrations given refers to tin mine workers. Here the workers were divided into two classes: (*a*) those employed underground, and (*b*) those working more or less in fumes of SO_2. Of the first class the percentage of cases during the autumn epidemic of influenza was 60·8, while in the other it was only 11·1%. Evidence of similar character having been secured in other trades, Captain Gregor comes to the conclusion that "from epidemiological evidence, though it does not cover a large number of people, it would seem that the popular belief in the cure of colds in the head by fumes has some foundation of truth."

GOVERNMENT COMMISSION OF INVESTIGATION.—As a result of the demands made upon the Government by the deputation from the Joint Industrial Council, and referred to in the last issue, the Government delegated to the Imperial Mineral Resources Bureau the duty of making a preliminary investigation into the position of the industry, and Dr. F. H. Hatch and Mr. W. Forster Brown, on behalf of the Bureau, have recently visited the principal mines in the Camborne-Redruth area, and also the St. Just mines and Wheal Kitty at St. Agnes. They have, at their request, been supplied with a mass of data relating to the operation of the mines between the year 1912 and 1918 inclusive, and it is interesting to note that among the inquiries they make, the two following pertinent ones occur:

(*1*) What immediate funds are necessary to maintain productiveness of the mine say for twelve months?

(*2*) What would be the unemployment benefit cost if the mine were stopped?

We cannot help thinking that these questions foreshadow the common-sense action which we suggested in these columns last month, namely, that the Government should subsidize certain of the mines to the extent of the average total out-of-work benefit for say twelve months, pending the State inquiry into the industry, which, we understand, has already been decided on, but which will take many months to complete. Let us take Basset as an example. At this mine approximately 350 people were employed last year. If we assume an average weekly out-of-work benefit of 35s. per week, when operations completely cease, the Government will be doling out, if the men cannot find work, no less a sum than £1,112 per week. If the Basset directors had known they could have called on the Government for a weekly subsidy to the extent of £1,112, it is surely more than probable that they would have decided to continue the struggle until the price of tin recovered, as it surely will with the expansion of trade, to a figure at which it can be produced in Cornwall at a profit even from the lower grade mines. This suggestion of a subsidy has at least three advantages over the out-of-work donation, for although the cost to the Government is practically the same, (*1*) the men will be kept by employment out of idleness, which is so demoralizing and fruitful of unrest, (*2*) the mines will be kept going over the reconstruction period, or, in other words, pending the return of natural conditions, and (*3*) raw materials will be produced which must, of necessity, be of value to the country either for export or for home use. We believe that Sir Lionel Phillips is Chairman of the Special Committee of the Imperial Mineral Resources Bureau, which is responsible for this investigation, and there is thus reason to be hopeful that something on these lines may be done. Anyhow, we trust that, whatever recommendations are made, they will have a better fate than those he made to the Minister of Munitions when giving up the Controllership of the Department for the Development of Mineral Resources. It is, of course, frequently a subterfuge of a Minister who wishes to side-track a demand to appoint a Commission to report, but we believe those concerned in the Cornish mining industry—both masters and men—are too determined to secure some measure of reparation from the Government (which is mainly responsible for the existing conditions) to be put off in this way. Substantial immediate financial help is the only remedy which will be of service in several cases, and if such help is not speedily forthcoming, then we shall see such mines as Grenville, Tincroft, Wheal Kitty, and even Dolcoath close down, for their resources are insufficient to enable them to weather the storm.

We have had the opportunity of seeing the comparative data prepared by one mine for submission to the Imperial Mineral Resources Bureau, and the differences are so striking that we give some of them below for the information of our readers, and as an illustration of the burden which the mines have had to bear in the matter of the increased cost of materials :

	1912			1918		
	£	s.	d.	£	s.	d.
Wax Candles, per doz. lb.		2	6		14	3
Detonators, per 1,000 ...	1	15	0	3	15	0
Fuse, per coil			4¾			8½
Gelignite, per ton... ..	65	0	0	145	0	0
Oil, per gallon		1	0		4	3
Leather, per lb.		1	8		4	0
Tallow, per cwt.	1	10	0	4	0	0
Steel, per ton	32	0	0	75	0	0
Coal, per ton	1	1	0	1	16	3

LETTERS TO THE EDITOR

Government Assistance for Non-Ferrous Mining.

The Editor :

Sir—The question of whether the British Government should or should not assist the non-ferrous mines of England is an interesting one. Without Government assistance the prospects of metal mining in England are extremely poor, and the question really resolves itself into whether or no the Government can afford to watch the extermination of this industry.

There are many ways of fostering an industry, and during the last few critical years we have seen nearly every method adopted. In fact where an industry is sufficiently wealthy to pull its own wires in the legislation of the country it has succeeded invariably in weathering the storms of war. More than this, it has converted the mighty power of those very storms to its own use with such success that it has created for itself profits of which it can no longer conceal the enormity or the scandal.

For one must indeed be dense if one does not remark how the shipowners with their ships falling like hail upon the bottom of the ocean have made the fortunes of their lives; or how the brewers have created undreamed of wealth at a crisis when they could ill be spared barley, malt, sugar, or transport facilities, the very essentials of their business.

It is true that some other industries which had not the power or wealth with which to swing their own legislation have been grudgingly assisted because their continuance was essential to the life of the State. And among these latter come the non-ferrous metal mines.

There was a time during the war when the German submarines came near to imposing defeat and incalculable disaster upon the British; then the Government suddenly realized that England's weakness consisted in that she was not self-supporting. They then began to take action to encourage and foster essential home industries. And the lead and zinc mines received the encouragement of a bonus and a guaranteed price for their products, under which stimulus, although no fortunes were made, they were able to live and "do their bit" toward winning the war.

But now the war is over and won, and the Government must again confine its energies, more so than ever, of course, to the strict pursuit of business from which it can see a profit. That is to say, reaction to pre-war conditions as soon as possible.

But actual pre-war conditions can never come again, and we must not forget that the war was very nearly lost at the commencement because we were completely unprepared and our enemy as completely prepared. When America at last intervened on our side our enemy had forged and was employing a weapon with which she was about to effect our extermination. That weapon was blockade.

To put it mildly, the discovery that England could be blockaded came as an incalculable shock to our leaders. The blockade ultimately failed because the enemy was himself defeated by blockade; but when Germany decided to blockade us at all cost she held a sword point at the Achilles heel of the British Empire, because England is entirely dependent on outside for the essentials of her existence. Is it then conceivable that the lessons so emphatically taught only a few months ago can be so soon forgotten? Apparently yes, for already the suggestion has been made and measures are being taken for withdrawing essential Government support from the all-important industries of the home production of copper, tin, lead, and zinc.

If the nation were now out of danger for all time this might be understood, but this is far from being the case. We are not yet even out of the present war. And England's danger must ever be from blockade.

Foresight is a quality which, as Mr. Churchill rightly said (February 22, 1919), we greatly need at the present time. After the great war has suddenly stopped, the temptation comes to us to let the present and the future shift for themselves. We must not think that our dangers are past. It has been well said that the price of safety is eternal vigilance.

Under these circumstances, for the Government to contemplate the possibility of checking the home production of such essential raw materials as the non-ferrous metals is something the seriousness of which ought to be brought home to the people.

Germany blockaded fought with her whole manhood for $4\frac{1}{2}$ years and twice came within an ace of winning the whole world. Had she not employed foresight and developed her essential home productions she could not have fought for six months. How did she treat her non-ferrous mining industry?

In the summer of 1898, having applied to the German Government for leave to visit the mines in the Harz mountains, I made an extensive visit which covered a period of six months. I was, I remember, struck by the extravagance with which the mines were worked, and was considerably puzzled at being told that the mines were being run by the German Government at a loss. Nor in fact was it until late in 1914 that the explanation occurred to me. These important deposits of lead and zinc were appreciated as a great national asset, and the work that was carried on was mainly development. My impression is that the actual production was not large, but there existed arrangements underground, at the mills, and at the neighbouring smelters of Altenau and Clausthal the necessary machinery for a very large output. Thus the Zellerfelde, the Kaiser-Wilhelm, and the Marien were all connected at a depth of 1,000 feet (300 metres) by an underground canal with the bottom of a shaft at Clausthal where the mill stood, about 2 miles away, the ore being conveyed in barges. In addition to this there was a capacious electric railway. The hydraulic pump at the Marien shaft with its cylinders, 5 inches thick of bronze, was one of the wonders of mining when it was erected. Many of the levels were kept open with expensive steel girders, and in the Kaiser-Wilhelm shaft (a circular one, 16 feet in diameter) the entire lining was of steel. This shaft took 14 years to sink to a depth of 900 metres, and contained a wonderful man-engine worked by hydraulic power. Throughout these mines the utilization of hydraulic power underground, the water coming from the streams of the Harz mountains, was a remarkable feature. Between the Kaiser-Wilhelm and Marien shafts there ran a railway driven by compressed air.

Most of these things were more wonderful 20 years ago than they are to-day, but their enumeration will suffice to show the scale on which these ore-bodies were developed by the German Government. At the same time the local smelters of Altenau, Clausthal, etc., were kept going with ores obtained at considerably less cost, no doubt from the world markets, but in case of a war and a blockade of Germany here was the machine in being for supplying the fatherland with zinc and lead.

There is something so obvious about the lesson that one can only marvel at the proposed torpidity of our Government toward similar industries at home. Perhaps they argue that the production of these metals in England is so small that it is inconsiderable as a substitute for foreign supplies. This may be so, but from what I have seen of the deposits of zinc blende and galena in the Lake District of Cumberland there exist there ore-bodies of primary importance, most of which have hardly been touched, and I am of opinion that they represent a concentration of mineral which compares favourably with that of the Harz mountains.

One thing is certain: practically none of these veins have been followed any distance below the water level, and it is the Government's duty to expend a sum of money not only in developing these mineral assets, but also in obtaining as quickly as possible some practical estimate of their importance. Whether they do or not will be the measure of how much they have learnt in the last five years.

SKIDDAW.

Keswick, February 26.

Wolfram in China.

The Editor:

Sir—Under "Review of Mining" in your November issue, I notice a paragraph headed "China," reading as follows: "Wolfram is being mined at many places in southern China, notably in the province of Kwangtung, and concentrates are being shipped to Japan and the United States through Hong Kong. Much of this pioneer work is being done by the Japanese, but an Englishman, Sir Paul Chater, has individually done more than anybody else."

The above statement is hardly fair to British enterprise. No pioneer work was done by the Japanese, though after a steady production of, and trade in, wolfram had been established by others, they came in as buyers of the mineral at Hong Kong and the Treaty Ports. When wolfram was found in the Kuangtung Province, Sir Paul Chater showed considerable enterprise in prospecting for wolfram in the "New Territory" section of the Colony. Two wolfram mines were opened up by Sir Paul and his associates, but only an infinitesimal part of the total China production has been won from these deposits. The real pioneers of the Chinese wolfram business are the Eastern Tungsten Co., Ltd., a British company having its head office and works at Kuala Lumpur, Federated Malay States. This was orginally known as "Wolfram (Selangor) Ltd," and has been mining, magnetically separating, and dealing in tungsten ores for over 10 years, not only in the Malay States, but in Siam and Burma. It was purchasing and shipping Chinese wolfram to the F.M.S. for concentration as early as 1914. In 1915 one its directors went to South China to stimulate the production of the mineral from that region, as a result of which works were later on opened by it in Hong Kong and buyers sent up from the F.M.S. to establish agencies at Canton and elsewhere in China.

CANTON.

Canton, January 27.

Malayan Geology.

The Editor:

Sir—On pages 254, 257 of your issue for November, 1918, certain remarks of mine concerning the officers of the Geological Society of London were published. I have been informed recently that my private commentary on Dr. W. R. Jones' paper was sent to a Fellow of the Society whom the officers regarded as acting for Dr. Jones in his absence from England and that they felt obliged to accept his alterations in the paper. They also thought I wished my notes to be used as they were. Under other and normal circumstances I would readily help anyone who wished to publish views on a scientific subject differing from mine, but I should certainly expect acknowledgment of my assistance.

J. B. SCRIVENOR.

Tring, February 2.

High Temperatures in Broken Ore.

The Editor:

Sir—Regarding the article in your October issue by Mr. A. B. Colquhoun, on the heating of broken ore in mines, and the invitation given to explanations of the causes, I should like to suggest that the cause is due to the iron sulphide present in the ore existing in the form of marcasite.

EDGAR HALL.

Silverspur, Queensland.
January 5.

PERSONAL.

EDWARD W. BERRY, professor of paleontology, and DR. JOSEPH T. SINGEWALD, Jr., professor of economic geology, in the Johns Hopkins University, Baltimore, are going to South America in April under the auspices of the George Huntington Williams Memorial fund. They will spend six or seven months in geological explorations in the Andes of Peru, Bolivia, and Chile.

R. H. P. BULLEN, superintendent of the Mysore gold mine, India, is here on leave.

WILLIAM BULLOCK, until recently manager at Erith for Fraser and Chalmers, Ltd., has been appointed manager at Sandycroft for Sandycroft, Limited.

C. A. BURDICK has been appointed general manager of the Nechako River mines, British Columbia.

G. SPENCER COMPTON has joined the Geological Survey of West Australia.

JOHN COOPER has gone to Zacatecas, Mexico.

MAJOR CECIL H. CROPPER, D.S.O., M.C., in charge of Tunnelling Companies, is demobilized.

I. D. D. DAIMPRE is returning to Canada for demobilization.

EDWARD DAWSON, consulting engineer, Cardiff, has been elected president of the South Wales Institute of Engineers.

JOHN A. DENNISON, of the Anglo-French Exploration Co., Ltd., having been demobilized, A. H. CURTIS, who has been acting for him in his absence, is resuming private practice at 70, Terminus Chambers, London, E.C.1.

T. J. DRAKELEY, lately lecturer in chemistry at the Wigan Mining and Technical College, has been appointed to a similar position at the Northern Polytechnic Institute, London.

L. B. EAMES, of the Dorr Company, has been in London and Cornwall for a few weeks on his return journey from Johannesburg to the United States.

COLONEL T. W. EDGEWORTH DAVID, D.Sc., F.R.S., gave a lecture before the Geological Society of London on February 26 on "Geology on the Western Front."

DR. J. W. EVANS has been elected a Fellow of the Royal Society.

W. H. GOODCHILD has returned from Cuba.

JAMES M. HOLMAN and J. LEONARD HOLMAN are paying a visit to South Africa.

BERTRAM HUNT has gone to Panama.

C. J. INDER is leaving for South America.

CHARLES E. JOBLING has returned to England from the Gold Coast.

A. E. KITSON, director of the Geological Survey of the Gold Coast, is now on tour in the Colony. He is also supervising the geological work of part of Togoland. He expects to return to England in June.

H. H. KNOX has been elected president of the Mining and Metallurgical Society of America.

CHARLES LEHMANN has gone to Santiago, Chile.

F. W. LINCK is expected here from Burma.

CAPTAIN FRANK LUSH is demobilized and is back in London.

V. F. STANLEY LOW has left for Kelantan, Malay Peninsula.

D. H. MCDOUGALL, president of the Nova Scotia Steel and Coal Company, and J. B. TYRRELL, consulting mining engineer, of Toronto, have been nominated for the office of President of the Canadian Mining Institute.

G. W. W. MACKINNON has been appointed a director in London of the Broken Hill South.

W. K. MALLETTE, of San Francisco, is designing a lead-smelting plant for the Pennaroya Company, Spain.

ROLF MARSTRANDER passed through London last month on his return to Norway from South America.

FRANK MERRICKS, Chief of the Mining Section of the Department of Iron and Steel Production, Ministry of Munitions of War, was entertained at a dinner held on February 5 at the Connaught Rooms, by his Area Representatives and Headquarters Staff.

AMBROSE MONELL has been re-elected to the board of the International Nickel Co., on the conclusion of his war work.

HARVEY S. MUDD is here from the United States.

C. W. PURINGTON has settled at Vladivostok, where his address is 45 Svetlanskaia.

GEORGE READMAN, SIR DAVID PAULIN, and ALEXANDER MCNAB, directors, are visiting the mines of the Arizona Copper Co. this month.

E. W. SANDEMAN has been demobilized.

WILLIAM SELKIRK has been appointed consulting engineer to the Northern Exploration Company, which operates in Spitsbergen.

G. E. STEPHENSON is leaving for Egypt.

DR. A. W. STICKNEY has left for Vladivostok.

G. GORDON THOMAS, one of the engineers of the Tin Areas group, has been elected a fellow of the Geological Society of London.

E. R. WATSON has been appointed president of the Balbach Smelting & Refining Co., Newark, New Jersey.

DAVID WILKINSON is intending to come to England from Johannesburg next month.

A. H. WILLIAMS has been appointed general manager for the Arica Mining Company, Chile.

We regret to record the death of GEORGE LEA WALKER, secretary and director of Walker Brothers (Wigan) Limited. He was the victim of pneumonia following influenza, and he was only in his 42nd year.

TRADE PARAGRAPHS

THE DENVER FIRE CLAY CO., of Denver, Colorado, send us a pamphlet relating to Professor Butler's blowpipe apparatus.

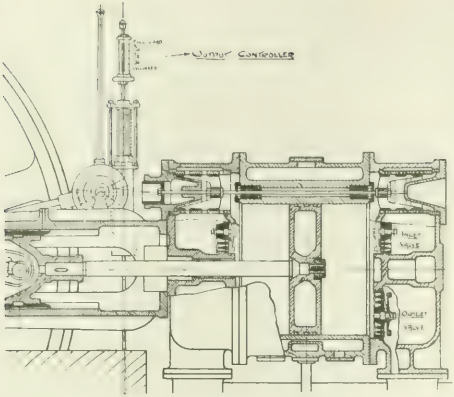
R. WHITE & SONS, Widnes, send us a pocket-size pamphlet giving details of their aerial ropeways, cable railways, light railways, rails, crossings, turn-tables, ore cars, and other specialties in transport.

THE BASIC SLAG ASSOCIATION has been formed in the interests of the makers of basic slag fertilizer in this country. The secretary is J. King Stewart, and the address 70, Fenchurch Street, London, E.C.3.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., LTD., Cambridge, send us a new pamphlet giving photographs of installations of their long-distance thermometers, thermographs, pyrometers, electro-cardiographs and oscillographs, containing also lists of users.

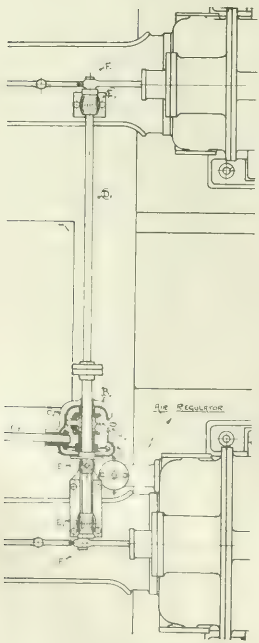
MANN, EGERTON & CO., LTD., motor and electrical engineers, of Norwich, Ipswich, and London, have bought the "Willett Light" business. Mr. Dean, who has been manager of the Willett Light for some years, remains in charge of the London office and showrooms in Sloane Square.

THE DAVIS FURNACE COMPANY, of Luton, are putting on the market a high-temperature heating furnace employing town gas, designed for working on the "Revergen" principle, the word "Revergen" being a trade mark. The method is an improvement on the regenerative system and high temperatures are gained with greatly reduced heat losses.



Sectional Elevation of Walker Controller

Walker Brothers (Wigan) Limited, of the Pagefield Iron Works, Wigan, send us information relating to their device for controlling the output of their horizontal air-compressors according to the demand when these machines are driven electrically. This output regulator is particularly applicable where the compressor has to work below its capacity owing to the demand for air not being sufficiently great, or where the charges for current are fixed in such a way that even a momentary "peak" will cause a serious increase in the scale of cost. A piston valve of the multi-ported type and of short travel is mounted in the centre of the upper portion of each cylinder cover. It is driven by a valve spindle which passes through the chamber in the water-jacket of the cylinder and is reciprocated by a connecting rod. The two connecting rods are driven by crank pins F mounted on shaft D which is supported by three bearings E of the ring lubricated type. The shaft is driven at the same speed as the engine through the shaft G and bevel wheels. The bevel wheel H, to which is secured the bevel wheel J, is bushed and runs loose upon the shaft, driving through the medium of the bevel pinion wheel C on the bevel wheel B, which is keyed fast to the shaft. The intermediate bevel pinion wheel C is mounted on bearings carried on the end of a lever, the position of which is controlled by the air regulator. The position of the wheel determines the angle of the shaft D and its crank relative to the crank shaft of the engines. It will be seen that a movement of the lever with its wheel through an angle of 60° will alter the relation of the shaft D relative to the crank shaft by double this amount of 120°. Any increase above the pre-determined pressure in the air receiver raises the plunger in the air regulator, and through it changes the position of the piston valve relative to the compressor piston. When in the top position it causes the former to be opened practically throughout the compression stroke, thus allowing the air to pass freely from the cylinder to the inlet valve chamber, thereby relieving the compressor of practically the entire compression load. On the rod connecting the air regulator to the lever carrying the bevel pinion wheel C, a hand wheel is provided, the rod, it should be noted, being made in two pieces with a connecting sleeve working on screwed threads. The length of the rod may be altered, so that when starting the engines it may be extended to the position of "no load" when running, even though the piston of the air regulator is in the bottom position. After full speed is attained the hand wheel may be rotated and the load gradually thrown upon the motor, the difference between the maximum and minimum length of the rod, as affected by the screwed sleeve, being equal to the full lift of the air regulator piston.



Plan of Walker Controller.

The Denver Engineering Works Company, of Denver, Colorado, the control of which has been recently acquired by the Hardinge Conical Mill Co., has enjoyed a large business in foreign trade, having shipped large numbers of electric hoists to Japan, as well as crushing and concentrating machinery to the Philippines and China. Shipments of crushing and concentrating machinery, also mine timber framers, have been made to the mining districts of South America. Ore concentrating devices have also been shipped to the mining districts of South Africa. The company has recently received orders for equipment of a large concentrating mill in Silverton, Colorado, where it has for several years furnished machinery for the plants of that section. Orders have also been received for an electric hoist of large capacity for the Compania Minera de Penoles, at Mapimi, Mexico. One of the first electric hoists used in Mexico was furnished by this company to the Compania Minera de Penoles, and during all these years the company has ordered electric hoists exclusively of the Denver Engineering Works. Since the Hardinge company acquired control of the Denver Co., Frank E. Shepherd has continued in his position as president in the latter company.

THE BRITISH REINFORCED CONCRETE ENGINEERING CO., LTD., 1, Dickinson Street, Manchester, has issued a book entitled "B.R.C. Reinforcements." In addition to information relating to the company's specialties, the book treats on the subject of reinforced concrete from the general technical and engineering point of view.

J. & E. WRIGHT, LTD., of Birmingham, send us a number of their pamphlets bound together in cloth. These deal respectively with their flattened strand and locked coil steel wire ropes, ropes for mining and general engineering purposes, wire-rope attachments, and preservative dressing for wire ropes. The book contains much useful information relating to wire ropes.

ALLEY & MACLELLAN, LTD., Glasgow, send us their catalogue relating to their air-compressors. These machines are well known under the name of "Sentinel," and are of the vertical type. In addition to compressors producing air suitable for rock-drills, the firm make 4-stage compressors producing pressures up to as much as 3,000 lb. per sq. in. The book contains a great deal of general information on air-compressors that will prove useful. The firm also send us their catalogue of steam stop-valves, check valves, water valves, and accessories.

THE STURTEVANT ENGINEERING CO., LTD., 147, Queen Victoria Street, London, E.C.4., send us new pamphlets relating to their balanced crushing rolls, rotary fine crushers of the open-door type, and the Newaygo screen separators, respectively. The Newaygo screen, as most of our readers are aware, is inclined and enclosed in a steel case so that dust is prevented from coming into the atmosphere, and it is submitted to a series of rapid and sharp taps given by hammers outside the steel case which impinge on pins connected with the screen. The vibrations are of small amplitude, so that they do not give any skidding or bounding motion to the particles, and the screening is done with remarkable rapidity.

Rock-drills made by HOLMAN BROTHERS, LTD., Camborne, played an important part in the record shaft-sinking operations at Crown Mines on the Rand in December. The shaft is vertical, 21 ft. 6 in. diameter, or 20 ft. clear. During 31 days, 297 ft. was sunk, and the cost per foot was £13. 4s. 8d., including the whole of the station cost but excluding walling. The average of rock hoisted per blast was 90 tons, equal to 8,100 tons for 30 sinking days, three blasts per day. The average native labour was 31 per shift in shaft per day, total 93 boys. White men in shaft: leading hand sinker, 1 per shift, 3 per day; second hand sinker, 1 per shift, 3 per day; stageman, 1 per day; master sinker, 1 per day; total in shaft per day, 8. Total other whites employed on surface: engine drivers, 3; boilermen, fitter blacksmith, machine men and masons, workshops, etc., 9; grand total 20. Total explosives used equalled 15 lb. per foot sunk. The machines used were 4 Holman torpedo sinkers, and 2 Holman hand-hammers.

RUSTON & HORNSBY, LTD., of Lincoln, were occupied almost entirely on war work during the past few years. Their output is detailed as follows: *War on land:* General service, spring, pontoon, limbered, and cable wagons, cable carts, and searchlight and bomb trailers, about 17,000; trench howitzer shell carriages, 4,000; diet, light, common, and flat-topped handcarts, Maltese, forest, trench, and tool carts, and Lewis gun carriages, 8,000; field kitchens, 2,000; water carts, water cart trailers, and portable clarifiers, nearly 4,000; portable pigeon lofts, disinfectors, and silicol hydrogen generators, 400; horse shoes, over 600,000; Ruston standard baling presses, and hay and straw transporters, and weighing machines, more than 1,000; wheels for motor lorries and heavy and light artillery, 28,000; machine gun mountings of various types, 13,500; gun mountings for guns of the following calibre, 3, 4, 6, and 12-pounders and 12-inch guns, 4,000; automatic belt-fillers for Maxim guns, 2,500; gun fittings, such as sights, director gear, calibration gear, elevating and training gear, 55,000; shells and bombs, including shells up to 13·5 in., and aircraft bombs up to 14 ft. 7in. in length and over 1½ tons in weight, over 500,000; components for shell and bombs, over 400,000; lethal gas apparatus, flame projectors, gas and oil-throwing accessories, about 250,000 items; trench pumps, over 2,500; caterpillar tractors, 440; tank trailers, tank engines, and tank sponsons, 300; three-throw pumps and shell presses for shell factories, kilns for manufacturing cement for trenches, gun emplacements, blockade work, etc., and vessels for explosive factories, saddles and axle trees for gun carriages, chain speed gears, axles, and gearings for motor lorries, etc. *War on the sea and under:* Marine engines for submarine and other boats, 127; parts for ditto, 8,000; submarine mines 30,000; components for same, 8,000; paravanes, over 2,000; carriers for depth charges, about 3,000; fittings for every class of vessel in the British Navy, from Dreadnoughts to mine layers, and mine sweepers, and for boom defence work, considerably over 1,500,000, together with large quantities of Admiralty and Scotch type boilers for drifters and mine sweepers, revolving torpedo tubes and platforms, etc. *War in the air:* Complete aeroplanes, 2,750; aero engines and equivalent spares, over 4,000.

METAL MARKETS

The following particulars are published of the stocks (exclusive of old metal and scrap) in this country in possession of the Minister of Munitions on March 1, 1919:

	Tons
Copper	51,373
Spelter G.O.B.	27,444
,, Refined	8,860
Aluminium	13,004
Soft Pig Lead	100,063
Nickel	2,332
Antimony Regulus	4,325

COPPER.—The market for this metal has seen a generally declining movement for the past month, principally owing to the steadily easing tendency noticeable in the American market, where business has been slow to revive, and with the necessary demand not forthcoming to relieve the position of the existing stocks, prices had to give way. The same remark applies more or less to the situation in this country. The Government stocks of the metal here on February 1 amounted to 41,882 tons, which revealed an increase of no less than 5,882 tons when compared with the

DAILY LONDON METAL PRICES: OFFICIAL CLOSING PRICES ON Copper, Lead, Zinc, and Tin per Long Tons; Silver

	Silver	Copper				Lead
		Standard Cash	Standard (3 mos.)	Electrolytic	Best Selected	Soft Foreign
Feb.	d.	£ s. d. £ s. d.	£ s d. £ s. d	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
12	$47\frac{7}{8}$	79 0 0 to 80 0 0	72 0 0 to 73 0 0	100 0 0 to 90 0 0	95 0 0 to 90 0 0	29 0 0 to 25 0 0
13	$47\frac{7}{8}$	79 0 0 to 80 0 0	72 0 0 to 73 0 0	100 0 0 to 90 0 0	95 0 0 to 90 0 0	29 0 0 to 25 0 0
14	$47\frac{7}{8}$	77 0 0 to 78 0 0	73 0 0 to 74 0 0	100 0 0 to 90 0 0	95 0 0 to 90 0 0	29 0 0 to 25 0 0
17	$47\frac{7}{8}$	75 0 0 to 76 0 0	72 0 0 to 72 10 0	90 0 0 to 84 0 0	95 0 0 to 90 0 0	28 10 0 to 25 0 0
18	$47\frac{7}{8}$	74 0 0 to 75 0 0	69 10 0 to 70 0 0	90 0 0 to 84 0 0	88 0 0 to 82 0 0	28 10 0 to 25 0 0
19	$47\frac{13}{16}$	74 0 0 to 75 0 0	69 0 0 to 69 10 0	90 0 0 to 84 0 0	88 0 0 to 82 0 0	28 0 0 to 25 0 0
20	$47\frac{3}{4}$	74 0 0 to 75 0 0	69 10 0 to 70 0 0	90 0 0 to 84 0 0	88 0 0 to 82 0 0	27 10 0 to 24 0 0
21	$47\frac{3}{4}$	74 0 0 to 75 0 0	69 10 0 to 70 0 0	90 0 0 to 84 0 0	88 0 0 to 82 0 0	27 10 0 to 24 0 0
24	$47\frac{3}{4}$	74 0 0 to 75 0 0	70 10 0 to 71 0 0	90 0 0 to 84 0 0	88 0 0 to 82 0 0	27 10 0 to 21 0 0
25	$47\frac{3}{4}$	74 0 0 to 75 0 0	70 0 0 to 71 0 0	90 0 0 to 84 0 0	87 0 0 to 82 0 0	27 10 0 to 21 0 0
26	$47\frac{3}{4}$	73 10 0 to 74 0 0	69 0 0 to 70 0 0	85 0 0 to 80 0 0	87 0 0 to 82 0 0	27 10 0 to 22 0 0
27	$47\frac{3}{4}$	74 10 0 to 75 10 0	70 0 0 to 70 10 0	85 0 0 to 80 0 0	87 0 0 to 82 0 0	28 0 0 to 22 10 0
28	$47\frac{3}{4}$	74 10 0 to 75 10 0	71 0 0 to 71 10 0	82 0 0 to 78 0 0	82 0 0 to 78 0 0	28 10 0 to 23 10 0
March						
3	$47\frac{3}{4}$	73 10 0 to 74 10 0	69 10 0 to 70 0 0	81 0 0 to 77 0 0	82 0 0 to 78 0 0	28 0 0 to 23 10 0
4	$47\frac{3}{4}$	74 0 0 to 74 10 0	70 0 0 to 70 5 0	80 0 0 to 76 0 0	80 0 0 to 75 0 0	28 0 0 to 23 10 0
5	$47\frac{3}{4}$	74 0 0 to 74 10 0	70 0 0 to 70 10 0	80 0 0 to 76 0 0	80 0 0 to 76 0 0	28 0 0 to 23 10 0
6	$47\frac{3}{4}$	74 0 0 to 74 10 0	70 0 0 to 70 10 0	80 0 0 to 76 0 0	80 0 0 to 76 0 0	28 0 0 to 25 0 0
7	$47\frac{3}{4}$	74 0 0 to 74 10 0	70 5 0 to 70 10 0	80 0 0 to 76 0 0	80 0 0 to 76 0 0	28 0 0 to 25 10 0
10	$47\frac{3}{4}$	77 0 0 to 77 10 0	73 0 0 to 73 10 0	80 0 0 to 76 0 0	80 0 0 to 76 0 0	28 0 0 to 25 10 0
11	$47\frac{3}{4}$	77 0 0 to 77 10 0	73 0 0 to 73 10 0	80 0 0 to 76 0 0	80 0 0 to 76 0 0	28 0 0 to 25 10 0

figures at the beginning of the previous month. The result of these factors has been a steady falling movement in values here, both of refined and standard copper, and although a certain amount of business has been passing, the general demand has not revived so quickly or to the extent that was expected after the cessation of hostilities. About the middle of the month the Government reduced its selling price for electrolytic to £92 and for best selected to £90, but since then official quotations of the Metal Exchange have come to an even lower level, and business has been reported in electrolytic for March shipment from America at round about £77 per ton. Business in manufactured copper has not been particularly brisk, although a little inquiry is seen. The best feature of this business has been the demand for plates for locomotive building. The curtailment in production in America has gradually been put into operation at the mines, which have cut down output to various extents up to about 50% of last year's figures. This, of course, is not yet reflected in any reduction in the amount of refined metal being turned out, as there were large quantities of blister copper on hand when the war ended, which are now being put through the refining process. It is reported that the Greene-Cananea Copper Co. has considerably reduced speed at its mines. The Mexican labour market very soon felt the effect of the restricted output of war materials in the States, following the signing of the Armistice, and the return of peons seeking work below the Rio Grande steadily increased. As a consequence the Greene-Cananea was able to increase production temporarily at the close of the year. January figures will, however, show a contraction. The formation of the Copper Export Association in America, has, of course, been one of the important factors of the copper market since the end of the war. This Association, which embraces the majority of the important producers, intends handling the export business. It is understood that every producer, large or small, in the country will be invited to join the Association, and prices will be averaged over monthly periods, and each producer will receive precisely the same price at the sea-board for his product. The metal is to be sold at a net price f.o.b. New York. It is pointed out that the production of American smelters and refineries was before the war 70% of that of the whole world. It is believed now to be about 85%. About 60% of the pre-war production was exported, and it is expected that proportion will continue to hold good.

Copper ores containing from 15% to 25% copper are valued around 14s. 6d. to 15s. per unit according to quality.

Average prices of cash standard copper: February 1919, £78. 10s. 3d.; January 1919, £93. 9s. 9d.; February 1918, £110. 5s.; January 1918, £110. 5s.

Our imports for January were 14,591 tons against 21,036 tons last year.

TIN.—This market has also seen a considerable drop in prices during the month, which was inevitable after the high figures which had previously been ruling. Business in the standard market has been for the most part very active, and sharp price fluctuations in both directions have been frequently seen. On balance, however, as already indicated, the tone has been downward, and about the middle of the month as low as £199 per ton was accepted for three-months metal. Since then, however, a considerable rally has been seen. The market has on the whole been very sensitive, a good deal of nervousness being at times apparent, this being no doubt due partly to the smallness of the stocks here. In spite of the latter fact, very heavy selling has been witnessed occasionally, which has been attributed to various sources; rumours were current that America was selling in this market, but this was only surmise and is unlikely to be correct. There is no doubt at all that at least a large portion of the selling was of a bear nature, which would account for the sharp upward turns which occasionally took place when covering operations were in progress. A factor of very considerable interest has been the position of the Federated Malay States Government vis-a-vis of the local mines. Reports were current at one time that the support which had been extended by that Government was withdrawn altogether, but this was hardly correct, the fact being that they had reduced the price at which they were prepared to take up the ore. The last figure quoted in this connection worked out at round about £202 per ton c.i.f. London for the actual tin. Meanwhile prices in the East are firm, and have generally ruled much above the parity of the London market. The American position shows no radical change, the import "monopoly" so called

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter)						Standard Tin											
						Cash						3 mos.					
£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
48	0	0 to	40	0	0	224	10	0 to	225	0	0	222	15	0 to	223	5	0
48	0	0 to	40	0	0	224	10	0 to	255	0	0	223	0	0 to	223	10	0
48	0	0 to	40	0	0	225	0	0 to	225	10	0	223	5	0 to	223	15	0
45	0	0 to	38	0	0	212	0	0 to	213	0	0	209	0	0 to	210	0	0
45	0	0 to	38	0	0	203	0	0 to	204	0	0	200	0	0 to	201	0	0
45	0	0 to	38	0	0	206	0	0 to	206	10	0	203	10	0 to	204	0	0
45	0	0 to	38	0	0	212	0	0 to	212	10	0	209	0	0 to	209	10	0
45	0	0 to	38	0	0	215	0	0 to	216	0	0	212	0	0 to	212	10	0
45	0	0 to	38	0	0	212	10	0 to	213	0	0	209	0	0 to	209	10	0
45	0	0 to	38	0	0	210	10	0 to	211	0	0	205	10	0 to	206	0	0
45	0	0 to	38	0	0	222	0	0 to	223	0	0	213	0	0 to	214	0	0
40	0	0 to	36	0	0	222	0	0 to	222	10	0	214	10	0 to	215	0	0
41	0	0 to	37	0	0	229	0	0 to	230	0	0	218	0	0 to	218	10	0
40	0	0 to	36	0	0	229	10	0 to	230	0	0	221	0	0 to	222	0	0
38	0	0 to	35	0	0	226	10	0 to	227	0	0	218	0	0 to	219	0	0
38	0	0 to	35	0	0	230	0	0 to	231	0	0	222	0	0 to	223	0	0
37	10	0 to	36	0	0	234	10	0 to	235	0	0	226	0	0 to	226	10	0
38	0	0 to	36	0	0	238	10	0 to	239	0	0	232	10	0 to	233	0	0
38	0	0 to	36	0	0	242	0	0 to	243	0	0	234	10	0 to	235	10	0
38	0	0 to	36	0	0	238	10	0 to	239	0	0	232	0	0 to	232	10	0

being continued. Locally smelted tin has, however, been selling there at lower than the official price of the United States Steel Products Co. Apparently, however, the stocks in their hands are gradually being diminished by buyers, who presumably require to have Straits metal. An interesting report is also current that America has sold a quantity to Scandinavia at a very high figure. The demand from consumers here has been fairly good, and should increase with the enlarging activities of the tin-plate mills, which are now working at something like two-thirds of pre-war output.

Average prices of cash standard tin were: February 1919, £224. 3s. 4½d.; January 1919, £248. 9s. 10d.; February 1918, £311. 12s. 3d.; January 1918, £293. 6s. 1d.

Our imports for January were 825 tons against 3,147 tons in the same month last year.

LEAD.—This market, like others, has seen a steadily declining tendency during the period under review. Early in the month the Government reduced their selling price to £30 per ton, and since then the Metal Exchange quotation came down to £27. 10s., although subsequently a slight rally was seen. Meanwhile forward metal was done down to £21, although in this case again values reacted once more in an upward direction. The position generally has not been one to inspire particular confidence among buyers of the metal, owing to the very large stocks at present in existence in this country. The stocks in the hands of the Government on February 1 amounted to 86,493 tons, which showed an increase against the previous month of as much as 23,641 tons. In the meantime the demand from the consuming trades has been rather slow to revive, owing to the tardy manner in which industrial enterprise such as building operations are being re-started. Latterly a slightly improved inquiry has been noticeable, however. The export business has not been important, mainly owing to the fact that the bulk of the overseas business has been done by America, and neutral countries now seem to have sufficient to go on with. Some metal has been exported from here, however, for Belgium, and shipments to Holland have also been sanctioned. The American price declined to 5c. per lb., but at that level rather a better tone was noticeable, and values rallied slightly, while their offerings to this side which had previously been rather pressing became less aggressive. The curtailment in production is in course of operation there, which it is stated may reduce output to about 50% of the normal yield. The suggestion is, in some quarters, that the drop in price was engineered for the purpose of bringing about this curtailment.

The average price for soft foreign lead: February 1919, £26. 13s.; January 1919, £34. 10s.; February 1918, £29; January 1918, £29.

The January imports of lead were 25,153 tons against 23,849 tons last year

SPELTER.—The spelter market has been considerably easier in the United States, and similar circumstances have prevailed here. The Government stock did not show any remarkable change at the beginning of February, the total of G.O.B. being 23,905 tons compared with 22,273 on January 1. Meanwhile the stock of refined showed a decrease of 283 tons, the figures on February 1 being 7,734 tons. Early in the month the Government reduced their selling price for G.O.B. to £50 and for fine spelter to £54. A further reduction subsequently took place when ordinary spelter came down to £45 and fine to £49 per ton. Since that date some free offerings on the Metal Exchange further depressed the quotation in the open market. Business with consumers has not revived to any important extent as yet, although a certain amount of hand-to-mouth demand was experienced. The market in America, as already indicated, has been easy at somewhat under 6½c. for prompt. A reduction in the output appears to be taking place in this metal also in America, and this may ultimately improve the position. As it is, the present figure is alleged to be below costs there.

The average prices for good ordinary brands: February 1919, £42. 11s. 6d.; January 1919, £50. 15s. 11d.; February 1918, £52; January 1918, £52.

The January imports of spelter were 11,187 tons against 10,981 tons in the same month last year.

ZINC DUST.—Australian 88-92% is quoted at £80 per ton f.o.r. Liverpool, English 75% £70 per ton at works.

ANTIMONY.—At the end of January the Government price of English regulus was reduced to £45, since when the market has been stationary so far as values go, while the demand has continued slow, little interest being displayed in the article. The Government stocks on February 1 amounted to 3,731 tons, which was an increase on those of a month earlier of 223 tons. Meanwhile values of crude have been more or less nominal, but recently a sale was reported at £40. Foreign regulus in warehouse here has also been slow of sale, prices ranging from £40 to a little above or below according to quantity.

ARSENIC.—The market has continued weak and values are now about £47. 10s.

BISMUTH.—12s. 6d. nominal per lb.

CADMIUM.—7s. 9d. to 8s. 6d. per lb.

ALUMINIUM.—£150 for home trade.

NICKEL.—£195 for home trade.

PLATINUM.—360s. to 440s. per oz.

PALLADIUM.—500s. per oz.

QUICKSILVER.—£20 to £22 per flask of 75 lb.

SELENIUM.—12s. to 15s. per oz.

TELLURIUM.—90s. to 100s. per oz.

SULPHATE OF COPPER.—£47 to £48 for export. £45 to £49 for home trade.

MANGANESE ORE.—About 3s. per unit c.i.f. U.K.

WOLFRAM ORE.—The Government is a seller of wolfram ore to approved consumers in this country at 40s. per unit for 65%, but they continue to take supplies from Empire producers at the old price, and apparently will do so for six months "after the war." The producers are therefore on velvet for a time longer, and meanwhile the difficulty is to get rid of the heavy stocks on hand here. The position in America is much the same, where there has been a sharp fall in prices, recent business having been done down to $7·50. Producers in neutral countries are being hard hit by the cessation of demand, and appear to be endeavouring, but unsuccessfully, to market their holdings. China seems particularly anxious in this respect.

MOLYBDENITE.—Nominal.

SILVER has been reduced to 47¾d. with the American quotation steady at 101⅛c.

COBALT METAL.—12s. 6d. to 13s. per lb

COBALT OXIDE.—7s. 9d. per lb.

CORUNDUM.—Nominal.

GRAPHITE.—80%, £45 c.i.f. U.K.

IRON AND STEEL.—A good deal of unsettlement has been felt in these markets owing to the general industrial unrest. The tendency now is for export demand for steel to expand, in spite of American competition in some quarters. Home business in manufactured material continues pretty good owing to the activity in the shipyards, while good inquiries have been seen for rails. The pig iron market has been fairly active, the demand in most cases exceeding the supply, and although export licences are now obtainable for some grades for neutrals little metal can be spared for shipment. A feature has been the continued scarcity of foundry qualities.

STOCKS OF TIN
Reported by A. Strauss & Co. Long Tons.

	Jan 31, 1919
	Tons
Straits and Australian Spot	1,128
Ditto, Landing and in Transit	365
Other Standard, Spot and Landing	728
Straits, Afloat	761
Australian, Afloat	—
Banca, on Warrants	—
Ditto, Afloat	—
Billiton, Spot	—
Billiton, Afloat	—
Straits, Spot in Holland and Hamburg	—
Ditto, Afloat to Continent	320
Total Afloat for United States	4,145
Stock in America	311
Total	7,758

SHIPMENTS, IMPORTS, SUPPLY, AND CONSUMPTION OF TIN.
Reported by A. Strauss & Co. Long tons.

	Jan. 1919
	Tons
Shipments from:	
Straits to U.K.	520
Straits to America	2,500
Straits to Continent	320
Australia to U.K.	—
U.K. to America	50
Imports of Bolivian Tin into Europe	1,199
Supply:	
Straits	3,340
Australian	300
Billiton	—
Banca	—
Standard	276
Total	3,916
Consumption:	
U.K. Deliveries	1,020
Dutch ,,	—
American ,,	1,850
Straits, Banca & Billiton, Continental Ports, etc	800
Total	3,670

PRICES OF CHEMICALS. March 10

		£	s.	d.
Alum	per ton	18	0	0
Alumina, Sulphate of	,,	20	0	0
Ammonia, Anhydrous	per lb.		1	10
,, 0·880 solution	per ton	34	0	0
,, Carbonate	per lb.			6
,, Chloride of, grey	per ton	50	0	0
,, ,, ,, pure	per cwt.	4	0	0
,, Nitrate of	per ton	80	0	0
,, Phosphate of	,,	125	0	0
,, Sulphate of	,,	17	10	0
Antimony Sulphide	per lb.		1	3
Arsenic, White	per ton	50	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	46	0	0
Bleaching Powder, 35% Cl.	,,	15	0	0
Borax	,,	42	0	0
Copper, Sulphate of	,,	48	0	0
Cyanide of Sodium, 100%	per lb.			10
Hydrofluoric Acid	,,			7
Iodine	,,		14	0
Iron, Sulphate of	per ton	7	10	0
Lead, Acetate of, white	,,	130	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	48	0	0
,, White	,,	55	0	0
Lime, Acetate, brown	,,	15	0	0
,, ,, grey 80%	,,	25	10	0
Magnesite, Calcined	,,	30	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate	,,	12	0	0
Methylated Spirit 64° Industrial	per gal.		8	7
Phosphoric Acid	per lb.		1	8
Phosphorus, yellow	,,		1	10
Potassium Bichromate	,,		2	0
,, Carbonate	per ton	110	0	0
,, Chlorate	per lb.		1	10
,, Chloride 80%	per ton	57	10	0
,, Hydrate, (Caustic) 90%	,,	260	0	0
,, Nitrate	,,	60	0	0
,, Permanganate	per lb		9	0
,, Prussiate, Yellow	,,		2	2
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	80	0	0
,, Arsenate 45%	,,	45	0	0
,, Bicarbonate	,,	8	10	0
,, Bichromate	per lb.		1	2
,, Carbonate (Soda Ash)	per ton	10	0	0
,, ,, (Crystals)	,,	4	5	0
,, Chlorate	per lb.			10
,, Hydrate, 76%	per ton	24	10	0
,, Hyposulphite	,,	18	0	0
,, Nitrate, 95%	,,	20	0	0
,, Phosphate	,,	30	0	0
,, Prussiate	per lb.			10
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)	,,	3	0	0
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	28	0	0
Sulphur, Roll	,,	22	0	0
,, Flowers	,,	28	10	0
Sulphuric Acid, Non-Arsenical 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		3	5
Zinc Chloride	per ton	23	0	0
Zinc Sulphate	,,	23	0	0

STATISTICS.

Production of Gold in the Transvaal

	Rand	Elsewhere	Total	Value
	Oz	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
Year 1916	8,971,359	324,179	9,295,538	39,484,934
Year 1917	8,714,866	307,527	9,022,493	38,323 921
January, 1918	694,121	19,991	714,182	3,033,653
February	637,571	22,188	659,759	2,802,477
March	677,008	19,273	696,281	2,957,614
April	697,733	19,366	717,099	3,046,045
May	720,539	20,778	741,317	3,148,915
June	708,908	18,788	727,696	3,091,058
July	716 010	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	640,797	17,904	656,701	2,797,983
December	630,505	10,740	641,245	2,723,836
Year 1918	8,197,959	221,734	8,419,693	35,768,688
January, 1919	662,205	13,854	676,059	2,871,718

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1918	176,424	11,469	4,715	192,608
February 28	181,066	11,243	4,825	197,134
March 31	183,055	11,076	4,745	198,876
April 30	182,492	11,322	4,753	198,567
May 31	179,879	11,211	4,773	195,863
June 30	179,028	11,473	4,747	195,248
July 31	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September 30	179,399	12,108	4,889	196,395
October 31	173,153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	160,599	11,848	3,539	175,986

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s d	s. d	s. d.	£
January, 1918	2,167,411	27 1	20 7	6 4	703,665
February	1,946,338	27 8	21 7	5 11	577,396
March	2,107,561	27 1	21 4	5 8	596,109
April	2,181,609	27 0	20 8	6 2	670,871
May	2,237,644	27 3	20 6	6 5	716,963
June	2,124,205	28 2	21 0	6 11	736,694
July	2,167,869	27 10	21 2	6 6	702,360
August	2,158,431	28 1	21 7	6 3	676,146
September	2,060,635	28 2	22 0	5 10	600,330
October	2,015,144	28 0	22 5	5 3	531,774
November	1,899,925	28 5	23 1	5 1	480,102
December	1,855,991	28 7	23 0	5 6	507,860
Year 1918	24,922,763	27 11	21 7	6 0	7,678,129

Production of Gold in Rhodesia and West Africa

	Rhodesia.		West Africa.	
	1918	1919	1918	1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	232,023	—	112,865	—
March	230,023	—	112,605	—
April	239,916	—	117 520	—
May	239,205	—	126,290	—
June	225,447	—	120,273	—
July	251,740	—	117,581	—
August	257,096	—	120,526	—
September	247,885	—	115,152	—
October	136,780	—	61,461	—
November	145,460	—	108,796	—
December	192,870	—	112,621	—
Total	2,652,250	211,917	1,333,553	104,063

Transvaal Gold Outputs.

	January, 1919	
	Treated	Value
	Tons	£
Aurora West	12,000	10,797
Bantjes	3,050	4,348
Brakpan	42,000	85,224
City & Suburban	15,579	28,160
City Deep	45 500	90,596
Cons. Langlaagte	41,300	51,645
Cons. Main Reef	44,310	67,682
Crown Mines	140,000	202,605
Durban Roodepoort Deep	23,200	34,581
East Rand P. M.	115,000	144,603
Ferreira Deep	37,240	59,834
Geduld	42,900	63,186
Geldenhuis Deep	47,400	55,842
Ginsberg	11,000	12,899
Glynn's Lydenburg	2,784	4,040
Goch	14,300	12,102
Government G.M. Areas	106,500	188,344
Heriot	11,900	3,547
Jupiter	26,400	27,539
Kleinfontein	45,740	56,904
Knights Central	17,900	27,277
Knights Deep	85,300	70,237
Langlaagte Estate	45,170	55,655
Luipaard's Vlei	19,560	139*
Meyer & Charlton	12,750	38,800
Modderfontein	76,000	168,309
Modderfontein B	58,000	127,635
Modderfontein Deep	44,400	88,589
New Unified	13,400	12,294
Nourse	35,000	49,484
Primrose	17,300	16,343
Princess Estate	18,000	20,329
Randfontein Central	143,000	160,901
Robinson	38,500	45,257
Robinson Deep	35,200	50,401
Roodepoort United	24,000	23,330
Rose Deep	48,000	54,684
Simmer & Jack	44,100	49,251
Simmer Deep	43,300	47,499
Springs	33,350	72,450
Sub Nigel	9,100	25,832
Transvaal G.M. Estates	11,380	14,128
Van Ryn	32,600	31,463
Van Ryn Deep	40,900	95,747
Village Deep	48,200	65,475
Village Main Reef	18,200	25,524
West Rand Consolidated	30,500	35,625
Witwatersrand (Knights)	35,550	38,158
Witwatersrand Deep	27,580	36,056
Wolhuter	29,250	35,697

* Loss.

West African Gold Outputs.

	January, 1919	
	Treated	Value
	Tons	£
Abbontiakoon	8,003	11,535
Abosso	6,602	10,931
Ashanti Goldfields	7,269	33,815
Prestea Block A	16,700	28,493
Taquah	5,150	14,678
Wassau	2,730	4,263

Rhodesian Gold Outputs.

	January, 1919	
	Treated	Value
	Tons	£
Antelope	3,280	5,501
Cam & Motor	—	—
Eldorado Banket	5,317	12,096
Falcon	13,514	26,416*
Gaika	3,363	5,458
Globe & Phœnix	5,514	7,167†
Lonely Reef	4,660	26,554
Rezende	5,200	13,538‡
Rhodesia, Ltd.	899	3,339
Shamva	51,050	36,631
Transvaal & Rhodesian	1,800	5,600
Wanderer	9,690	3,641

* Gold, Silver, and Copper; † Gold & Silver; ‡ Ounces Gold.

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January, 1918	*	73,703	*	*
February	*	76,987	*	*
March	*	69 730	*	*
April	*	66,079	*	*
May	*	73,701	*	*
June	*	74,904	*	*
July	*	72,081	*	*
August	*	76,156	*	*
September	*	74,057	*	*
October	*	71,439	*	*
November	1,444	70,711	72,155	306,494
December	2 739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779

* By direction of the Federal Government the export figures from July, 1916, to November, 1918, were not published.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1917	1918	1917	1918	1918	1919
	£	£	£	£	£	£
January	67,627	32,134	50,150	47,600	25,000	17,000
February	65,450	58,113	63,200	45,470	28,000	—
March	74,794	65,412	61,200	48,020	30,000	—
April	75,139	26,849	62,470	47,600	30,000	—
May	65,623	87,885	65,450	46,740	45,000	—
June	64,180	45,765	73,100	51,420	32,000	—
July	68,937	64,347	71,820	51,000	25,000	—
August	101,428	61,163	74,800	44,600	21,000	—
September	61,701	65,751	64,180	45,900	32,000	—
October	33,533	—	54,400	54,400	40,000	—
November	75,912	—	42,380	38,200	25,000	—
December	56,967	—	64,170	52,800	38,000	—
Total	846,540	508,853	744,537	553,750	370,000	17,000

Australasian Gold Outputs.

	January, 1919	
	Treated	Value
	Tons	£
Associated	6,217	9,146
Associated Northern Blocks { Iron Duke	—	3,315*
Associated Northern Blocks { Victorious	1,536	2,415
Blackwater	1,443	2 954
Bullfinch	4,710	5,221
Golden Horseshoe	11,760	23,380
Great Boulder Prop.	12,763	38,299
Kalgurli	3,467	6,666
Ivanhoe	17,642	28,770
Lake View & Star	9,670	11,463
Oroya Links	1,551	13,815†
Progress	1,330	1,426
Sons of Gwalia	13,051	17,072
South Kalgurli	7,724	11,127
Talisman	690	6,285
Waihi	11,079	18,306‡
Waihi Grand Junction	—	—

* Total receipts; † Surplus; ‡ Gold and Silver, 18 days.

Miscellaneous Gold Output.

	January, 1919	
	Treated	Value
	Tons	£
Barramia (Sudan)	1,165	637
Esperanza (Mexico)	12,736	1,143†
Frontino & Bolivia (Colombia)	2,118	8,095
Nechi (Colombia)	82,533*	13,949‡
Ouro Preto (Brazil)	5,100	7,550
Pato (Colombia)	63,928*	11,261‡
Philippine Dredges (Philippine Islands)	—	511§
Plymouth Cons. (California)	10,300	12,901
St. John del Rey (Brazil)	—	36,000
Santa Gertrudis (Mexico)	30,970	24,723††
Sudan Gold Field (Sudan)	1,750	3,100

* Cubic yards; † Profit; ‡ Dollars; § Ounces, fineness not stated. †† Profit, gold and silver

Production of Gold in India

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	162,270
February	183,264	180,904	173,343	—
March	186,475	189,618	177,950	—
April	192,208	185,835	176,486	—
May	193,604	184,874	173,775	—
June	192,469	182,426	174,375	—
July	191,404	179,660	171,950	—
August	192,784	181,005	172,105	—
September	192,330	183,630	170,360	—
October	191,502	182,924	167,740	—
November	192,298	182,388	157,176	—
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	162,270

Indian Gold Outputs.

	January, 1919	
	Tons Treated	Fine Ounces
Balaghat	2,400	2,003
Champion Reef	11,962	6,988
Hutti (Nizam's)	—	900
Jibutil	—	450
Mysore	24,399	13,286
North Anantapur	1,200	950
Nundydroog	8,564	6,584
Ooregum	12,800	7,473

Base Metal Outputs.

		January, 1919
Arizona Copper	Short tons copper	1,800
British Broken Hill	Tons lead concentrate	2,153
	Tons zinc concentrate	1,945
	Tons carbonate ore	529
Broken Hill Block 10	Tons lead concentrate	802
	Tons zinc concentrate	1,045
Burma Corp.	Tons refined lead	1,813
	Oz. refined silver	212,000
Freemantle Trading	Long tons lead	575
North Broken Hill	Tons lead	1,508
	Oz. silver	64,435
Poderosa	Tons copper ore	158
Rhodesian Broken Hill	Tons lead and zinc	587
Tanganyika	Long tons copper	1,487
Tolima	Tons silver-lead concentrate	30
Zinc Corp.	Tons zinc concentrate	5,330
	Tons lead concentrate	2,455

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1918	Jan. 1919	Feb. 1919
	Tons	Tons	Tons
Iron Ore	6,565,860	555,264	409,610
Copper Ore	15,319	3,789	898
,, Precipitate	21,031	1,954	498
,, Metal	203,943	14,591	14,258
Copper and Iron Pyrite	836,703	33,942	21,873
Tin Concentrate	32,329	5,754	3,736
,, Metal	12,567	825	587
Manganese Ore	365,606	33,215	24,031
Lead, Pig and Sheet	208,932	25,153	26,336
Zinc (Spelter)	64,138	11,187	9,138
Zinc Oxide	3,989	226	5
Barytes	1,480	270	289
Rock Phosphate	464,747	70,587	27,704
Brimstone	72,720	5,010	—
Boracic Compounds	9,282	2,185	24,800
Nitrate of Potash	19,184	758	8,169
	lb.	lb.	lb.
Quicksilver	1,077,460	—	—

Exports of Copper from United States

1917	Long tons	1918	Long tons	1918	Long tons
July	38,127	January	40,530	July	28,826
August	45,304	February	28,160	August	20,440
September	30,493	March	22,550	September	32,730
October	39,115	April	22,227	October	15,218
November	38,638	May	28,889	November	19,570
December	35,000	June	31,791	December	18,869
Total 1917	484,120	...	...	Total 1918	309,800

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Dec. 1918 Tons	Year 1918 Tons	Jan 1919 Tons
Nigeria:			
Abu	–	33	2
Anglo-Continental	16	207	25
Benue	7	146	8
Bisichi	20	275	10
Bongwelli	–	15	4
Dua	9	60	9
Ex-Lands	26	342	30
Filani	2	37	–
Forum River	15	274	16
Gold Coast Consolidated	–	30	–
Gurum River	12	99	10
Jantar	12	141	12
Jos	18	228	24
Kaduna	22	178	24
Kano	12	60	17
Kassa-Ropp	10	133	12
Keffi	6	118	8
Kuru	12	12	16
Kuskie	1	21	1
Kwall	4	108	–
Lower Bisichi	8	99	10
Lucky Chance	2	27	2
Minna	–	40	2
Mongu	35	476	50
Naraguta	31	478	34
Naraguta Extended	27	280	20
New Lafon	20	198	–
Nigerian Tin	8	87	7
N.N. Bauchi	20	435	25
Offin River	11	120	–
Rayfield	55	689	60
Ropp	64	836	98
Rukuba	9	132	9
South Bukeru	3	94	5
Sybu	2	40	2
Tin Areas	7	96	6
Tin Fields	7	108	18
Toro	1	17	1
Federated Malay States:			
Chenderiang	45	179	–
Gopeng	86	979	87
Idris Hydraulic	14	136	21
Ipoh	16	245	4
Kamunting	71	236	–
Kinta	42	478	42
Kledang	10	28	–
Lahat	18	399	36
Malayan Tin	50	730	56
Pahang	153	1,877	154
Rambutan	16	207	18
Sungei Besi	42	408	21
Tekka	47	508	47
Tekka-Taiping	30	400	41
Tronoh	132	1,364	150
Tronoh South	2	133	–
Cornwall:			
Cornwall Tailings	–	140	–
Dolcoath	62	787	59
East Pool	142	1,336	127
Geevor	–	369	–
South Crofty	38	598	40
Other Countries:			
Aramayo Francke (Bolivia)	185	1,816	200
Briseis (Tasmania)	20	327	15
Deebook (Siam)	39	398	43
Mawchi (Burma)	50	658	73
Porco (Bolivia)	21	227	27
Renong (Siam)	50	615	39
Rooiberg Minerals (Transvaal)	30	335	33
Siamese Tin (Siam)	71	989	76
Tongkah Harbour (Siam)	87	1,528	130
Zaaiplaats (Transvaal)	45	563	55

Nigerian Tin Production

In long tons of concentrate of unspecified content

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	582
February	469	358	528	646	668	—
March	502	418	547	655	707	—
April	482	444	486	555	584	—
May	480	357	536	509	525	—
June	460	373	510	473	492	—
July	432	455	506	479	545	—
August	228	438	498	551	571	—
September	289	442	535	538	520	—
October	272	511	584	578	491	—
November	283	467	679	621	471	—
December	326	533	654	655	517	—
Total	4,708	5,213	6,594	6,927	6,769	582

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Total, 1917	4,186	£561,003	£134 0 0
January 14, 1918	141	£23,563	£167 2 3
January 28	171½	£28,976	£168 19 2
February 11	166½	£29,674	£178 4 6
February 25	156½	£28,213	£180 18
March 11	178¼	£33,398	£187 7 4
March 25	169½	£31,253	£184 7 9
April 8	157¼	£29,575	£188 1 8
April 22	159½	£31 402	£196 17 7
May 6	172½	£39,999	£232 4 4
May 21	169½	£36,791	£217 1 2
June 3	172	£36,109	£209 18 9
June 18	153	£29,692	£194 1 9
July 1	170½	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£231 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£28,793	£202 1 2
September 24	145¾	£29,639	£203 7 2
October 7	136½	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	165¾	£25,170	£150 19 0
December 16	175½	£26,032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786,541	£192 0 0
January 13, 1919	160	£20,838	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24	142	£15,015	£105 14 10

Details of Redruth Tin Ticketings.

	February 10		February 24	
	Tons Sold	Realized per ton £ s d	Tons Sold	Realized per ton £ s. d.
E. Pool & Agar, No. 1	12	115 0 0	14	102 15 0
,, ,, No. 1a	12	112 0 0	13	103 5 0
,, ,, No. 1b	15	113 0 0	13	104 5 0
,, ,, No. 1c	13	111 5 0	—	—
Dolcoath, No. 1	9	118 7 6	9	110 10 0
,, No. 1a	9	118 10 0	9	111 7 6
,, No. 1b	9	117 12 6	9	111 12 6
,, No. 2	3½	55 0 0	3½	51 7 6
,, A	1½	98 15 0	1½	93 5 0
South Crofty, No. 1	10	115 10 0	10	108 10 0
,, ,, No. 1a	10	115 10 0	11	109 5 0
Grenville Utd., No. 1	7	110 7 6	9	108 10 0
,, ,, No. 1a	6	110 0 0	2½	31 15 0
,, ,, No. 2	—	—	—	—
Tincroft Mines, No. 1	7	120 10 0	7	114 10 0
,, ,, No. 1a	7	121 10 0	8	115 5 0
Levant Mines	15	109 10 0	13	114 15 0
Basset Mines	5	112 0 0	5	105 7 6
Wheal Bellan	—	—	2	110 0 0
Hingston Downs	4	120 7 6	—	—
Botallack Bottoms	—	—	1½	102 10 0
Trencrom Hill	—	—	1	100 0 0
Total	153		142	

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	March 7, 1918 £ s. d.	March 7, 1919 £ s. d.
RAND		
Bantjes	3 6	3 0
Brakpan	5 0 0	3 16 3
Central Mining (£8)	6 3 9	8 3 9
Cinderella	4 3	6 0
City & Suburban (£4)	1 0 0	12 0
City Deep	2 19 6	2 13 0
Consolidated Gold Fields	1 16 6	1 15 0
Consolidated Langlaagte	18 0	18 0
Consolidated Main Reef	15 6	15 6
Consolidated Mines Selection (10s).	1 10 6	1 8 6
Crown Mines (10s.)	1 15 0	2 6 3
Daggafontein	1 10 0	1 10 6
D. Roodepoort Deep	10 0	8 9
East Rand Proprietary	5 9	5 0
Ferreira Deep	14 6	13 0
Geduld	2 0 6	2 12 0
Geldenhuis Deep	14 6	13 0
Gov't Gold Mining Areas	3 13 0	4 15 6
Heriot	1 10 0	18 9
Jupiter	5 9	4 6
Kleinfontein	1 0 6	14 0
Knight Central	4 0	5 6
Knight's Deep	9 6	8 6
Langlaagte Estate	14 0	19 0
Meyer & Charlton	5 11 3	4 10 0
Modderfontein (£4)	23 2 6	27 5 0
Modderfontein B	8 6 3	7 18 9
Modder Deep	7 10 0	7 10 0
Nourse	18 9	16 3
Rand Mines (5s.)	2 16 3	3 0 6
Rand Selection Corporation	4 13 9	4 1 3
Randfontein Central	11 9	14 3
Robinson (£5)	16 3	15 0
Robinson Deep A (1s.)	1 3 9	18 9
Rose Deep	18 9	17 6
Simmer & Jack	5 0	5 0
Simmer Deep	3 3	3 0
Springs	3 14 6	3 11 3
Sub Nigel	1 6 3	1 10 0
Van Ryn	1 0 6	17 0
Van Ryn Deep	3 11 3	3 11 3
Village Deep	1 0 0	17 6
Village Main Reef	12 6	14 6
Witwatersrand (Knight's)	1 12 0	1 1 3
Witwatersrand Deep	7 6	11 0
Wolhuter	6 6	5 0
OTHER TRANSVAAL GOLD MINES		
Glynn's Lydenburg	1 0 0	1 3 9
Sheba (5s.)	1 0	1 3
Transvaal Gold Mining Estates	16 6	14 0
DIAMONDS IN SOUTH AFRICA		
De Beers Deferred (£2 10s.)	12 17 6	19 2 6
Jagersfontein	4 6 3	4 17 6
Premier Deferred (2s. 6d.)	7 7 6	7 7 6
RHODESIA		
Cam & Motor	11 6	8 0
Chartered British South Africa	15 0	1 1 6
Eldorado	7 6	6 0
Falcon	1 5 9	13 3
Gaika	1 0 0	15 6
Giant	8 3	7 3
Globe & Phœnix (5s.)	1 10 6	1 9 6
Lonely Reef	1 14 6	1 19 0
Rezende	4 10 0	4 18 9
Shamva	1 15 0	1 17 6
Wanderer (3s.)	1 6	1 3
Willoughby's (10s.)	5 3	6 6
WEST AFRICA		
Abbontiakoon (10s.)	4 0	4 9
Abosso	7 9	6 6
Ashanti (4s.)	1 1 3	1 1 6
Prestea Block A	4 3	5 0
Taquah	16 0	14 6
WEST AUSTRALIA		
Associated Gold Mines	3 3	4 6
Associated Northern Blocks	2 6	4 3
Bullfinch	1 9	1 9
Golden Horse-Shoe (£5)	2 1 3	1 15 6
Great Boulder Proprietary (2s.)	13 0	12 3
Great Fingall (10s).	2 0	2 0
Ivanhoe (£5)	1 13 9	1 17 6
Kalgurli	9 3	12 6
Sons of Gwalia	9 6	8 6

GOLD, SILVER, *cont.*	March 7, 1918 £ s. d.	March 7, 1919 £ s. d.
OTHERS IN AUSTRALASIA		
Mount Boppy, New South Wales	7 6	3 9
Talisman, New Zealand	16 3	12 6
Waihi, New Zealand	1 18 0	2 2 6
Waihi Grand Junction, New Z'lnd	17 0	15 0
AMERICA		
Alaska Treadwell (£5), Alaska	—	2 0 0
Buena Tierra, Mexico	10 0	1 1 3
Camp Bird, Colorado	7 9	17 6
Casey Cobalt, Ontario	9 0	4 0
El Oro, Mexico	9 9	16 6
Esperanza, Mexico	9 9	17 3
Frontino & Bolivia, Colombia	13 9	11 3
Le Roi No. 2 (£5), British Columbia	7 6	8 9
Mexico Mines of El Oro, Mexico	5 12 6	6 12 6
Oroville Dredging, California	19 6	1 0 0
Plymouth Consolidated, California	1 2 6	1 2 6
St. John del Rey, Brazil	18 0	17 6
Santa Gertrudis, Mexico	13 6	17 9
Tomboy, Colorado	19 0	15 0
RUSSIA		
Lena Goldfields	1 5 0	1 15 0
Orsk Priority	16 3	12 6
INDIA:		
Balaghat	4 9	4 6
Champion Reef (2s. 6d.)	5 6	4 3
Mysore (10s.)	2 18 9	2 3 9
North Anantapur	5 3	3 0
Nundydroog (10s.)	1 5 0	1 2 0
Ooregum (10s.)	18 9	16 6
COPPER:		
Arizona Copper (5s.), Arizona	2 6 3	1 17 6
Cape Copper (£2), Cape Province	2 15 0	2 12 6
Chillagoe (10s.), Queensland	1 3	1 6
Cordoba (5s.), Spain	3 0	3 0
Great Cobar (£5), N.S.W.	2 0	3 0
Hampden Cloncurry, Queensland	1 10 3	1 0 6
Kyshtim, Russia	1 0 0	1 12 0
Messina (5s.), Transvaal	8 6	5 0
Mount Elliott (£5), Queensland	3 15 0	3 10 0
Mount Lyell, Tasmania	1 8 3	1 4 0
Mount Morgan, Queensland	1 14 6	1 4 6
Namaqua (£2), Cape Province	2 12 6	2 0 0
Rio Tinto (£5), Spain	64 5 0	61 0 0
Sissert, Russia	17 6	1 1 3
Spassky, Russia	1 1 3	1 10 0
Tanalyk, Russia	1 0 0	1 18 9
Tanganyika, Congo and Rhodesia	3 10 0	4 13 9
Tharsis (£2), Spain	6 12 6	5 15 0
LEAD-ZINC:		
BROKEN HILL		
Amalgamated Zinc	1 11 6	1 12 0
British Broken Hill	1 18 9	2 3 9
Broken Hill Proprietary (8s.)	3 7 6	2 10 0
Broken Hill Block 10 (£10)	1 15 0	1 10 6
Broken Hill North	3 0 3	2 18 9
Broken Hill South	10 10 0	2 18 9*
Sulphide Corporation (15s.)	1 7 0	1 4 0
Zinc Corporation (10s.)	1 2 9	1 5 9
ASIA		
Burma Corporation	4 5 6	5 5 0
Irtysh Corporation	1 2 6	1 13 9
Russian Mining	10 0	17 6
Russo-Asiatic	2 8 9	3 13 9
TIN.		
Aramayo Francke, Bolivia	1 18 9	3 2 6
Bisichi, Nigeria	15 0	14 0
Briseis, Tasmania	5 6	5 0
Dolcoath, Cornwall	12 6	8 0
East Pool, Cornwall	1 4 9	1 5 9
Ex-Lands Nigeria (2s.), Nigeria	2 0	2 9
Geevor (10s.) Cornwall	19 0	15 6
Gopeng, Malay	1 16 3	2 0 0
Ipoh Dredging, Malay	16 9	1 1 6
Malayan Tin Dredging, Malay	2 2 6	2 5 0
Mongu (10s.), Nigeria	15 0	16 0
Naraguta, Nigeria	18 0	19 0
N. N. Bauchi Pref. (10s.), Nigeria	12 6	13 0
" Ord. (10s.)	6 0	8 0
Pahang Consolidated (5s.), Malay.	13 6	15 0
Rayfield, Nigeria	12 9	14 0
Renong Dredging, Siam	2 11 3	2 0 0
Ropp (4s.), Nigeria	1 0 6	1 1 9
Siamese Tin, Siam	3 2 6	3 3 9
South Crofty (5s.), Cornwall	1 10 9	2 0 0
Tekka, Malay	3 12 6	3 10 0
Tekka-Taiping, Malay	3 15 0	3 17 6
Tronoh, Malay	1 13 9	1 17 6

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers: also reviews of new books, and abstracts of the yearly reports of mining companies

MAGNESITE, ITS OCCURRENCE AND USES

(Continued from the February issue, page 120).

We continue our reprint of Mr. Crook's paper on Magnesite, read at the Swansea meeting of the Ceramic Society.

BREUNNERITE.—It is customary to refer to all spathic magnesium carbonate as crystalline magnesite regardless of the percentage of ferrous carbonate present. The procedure adopted in this paper is to distinguish two separate types of spathic material, namely, breunnerite and magnesite proper. Under the breunnerite type is included such spathic material as contains from 5 to 30% of isomorphously mixed ferrous carbonate. Spathic magnesium carbonate containing less than 5% of ferrous carbonate is classed as spathic magnesite and will be dealt with in the next section.

Breunnerite is widely distributed, but as yet only the Austro-Hungarian deposits have proved to be of economic value. As showing this wide distribution, reference is made in the following paragraphs to deposits containing the mineral in Canada, India, and the United Kingdom, but many other occurrences are known.

Austria-Hungary.—The only deposits of the breunnerite type that have hitherto proved to be of economic importance are those of the metamorphosed Carboniferous strata of Styria, Lower Austria, and Northern Hungary. Breunnerite is abundant in this region, which is famous also for its spathic iron ores. It is noteworthy that the largest of the world's known deposits of the mineral chalybite occurs at Eisenerz in Styria, while the world's largest known deposit of breunnerite occurs at Veitsch, in the same province. Spathic manganese ore, rhodochrosite, has also figured as a mineral of economic importance in Styria, and some of the deposits of spathic ore in this region are of a very mixed description. For information as to the geology and mineralogy of the magnesite deposits of this region we are indebted chiefly to F. Foetterle (*Jahrb. der k. k. Geol. Reichanstalt*, 1852 and 1855,) J. Rumpf (*Tschermak's Min. Mitt.*, 1873, p, 263), K. A. Redlich (various papers in *Zeit. f. Prakt. Geol.*, and Doelter's *Handbuch der Mineralchemie*, Band 1 p. 243), and F. Cornu (*Zeit. f. Prakt. Geol.*, 1908).

The Styrian and Lower Austrian deposits have the advantage that they are much nearer their Adriatic port than are those of Northern Hungary, and it is from them that most of the Austro-Hungarian magnesite hitherto exported has been obtained. They are situated in the region to the south-west of Vienna, along a tract extending westward from Semmering through the Mürz valley to the Tyrol. The chief deposits, taking them in order from east to west, are those of Semmering, Veitsch, Breitenau, Trieben, Radenthein, and Dienten. Of these the largest and most important appears to be that of Veitsch, which is situated near Mitterdorf, a station on the South Austrian railway in the Mürz valley, in Styria. The geological structure of this district, like that of so many parts of the Alpine region, is very complicated. The magnesite occurs as lenticular masses in a belt of foliated Carboniferous rocks belonging to the so-called greywacke zone. They are chiefly metamorphosed shales, sandstones, and conglomerates, but include a limestone the fossils of which show it to be of Viséan (Lower Carboniferous) age. The chief lenticular mass of magnesite near Veitsch forms the main part of the Sattlerkogels, a hill lying a kilometre or so to the north-west of the village. The summit of the Sattlerkogels is about 3,260 ft. above sea-level, and nearly a 1,000 ft. above the level of the Veitsch works. The magnesite is quarried on the slope of the hill in a series of terraces about 50 ft. apart through a vertical distance of nearly 500 ft. The magnesite lens is three-quarters of a mile in length, and over a 1,000 ft. in width. So far as can be judged from its disposition it probably extends to a considerable depth.

The dominant minerals of the Sattlerkogels magnesite deposit, as described by Cornu, are magnesite and dolomite. Scaly masses and films of talc are associated with the magnesite. Flakes of rumpfite, a hydrated silicate of magnesium and aluminium, are associated with the dolomite. Minerals occurring as infillings of cavities in the rock include quartz, dolomite, ankerite, calcite, rumpfite, pyrolusite, and pyrites. Sulphide veins traversing the rock include quartz, pyrite, copper pyrites, and fahlerz. The magnesite occurs largely in coarse crystalline masses, and to some extent also in the condition of the so-called pinolite. The name pinolite is a refinement by Rumpf of the Styrian quarryman's pinolistein, and applies to a rock consisting of crystals and aggregates of white magnesite in a matrix of schist (phyllite or talc-schist). The rock appears to have been formerly used as an ornamental stone in Austria, and derived its name from the supposed structural resemblance of the magnesite nodules to the cones of *Pinus pinea*.

The magnesite of Veitsch and many other localities in this region is of the breunnerite variety. It is greyish in colour when fresh, and contains sufficient isomorphously intergrown ferrous carbonate to blacken when calcined in a reducing atmosphere. In this respect it behaves like the white patches of ankerite seen in most specimens of English coal. It also behaves like ankerite in turning brown when exposed to the air. The amount of iron carbonate is variable, and various analyses show percentages ranging up to 13 or 14%. A little pyrite is present in the form of scattered granules, more especially in the pinolite variety.

Although selected specimens of the Sattlerkogels breunnerite show so much variation in the percentage of ferrous carbonate present, there is comparatively little variability in the percentage of iron oxide in the sintered product as marketed. This may be seen from five analyses of sintered magnesite quoted by Cornu, which show variation between the following limits: Magnesia (MgO) 85·53 to 90·07, Lime (CaO) 0·96 to 3·52, Ferric oxide (Fe_2O_3) 7·43 to 9·96, Manganese oxide (Mn_3O_4) 0·51 to 0·76, Silica (SiO_2) 0·26 to 1·34, Alumina (Al_2O_3) *nil* to 2·22.

A. Kern (in *Glückauf*, 1912) quotes the following analyses of sintered magnesite from some of the more important Austrian localities:

	Veitsch	Breitenau	Semmering	Sunk	Salzburg
	%	%	%	%	%
Magnesia (MgO)	84·2	87·9	85·9	85·9	86·7
Lime (CaO) ...	2·5	2·8	3·0	4·5	2·0
Ferric oxide (Fe_2O_3)	8·4	5·5	5·3	6·8	5·9
Alumina (Al_2O_3) .	—	0·7	0·1	1·4	1·1
Silica (SiO_2)	3·8	2·0	5·1	0·6	2·2

The smaller variation in composition shown by the sintered material as compared with selected specimens of the raw magnesite is doubtless due to the moderating effect of the crushing, dressing, and sintering operations, which are accompanied by a fairly thorough mixing of the ground material.

According to Cornu, dolomite is abundant in the Veitsch magnesite deposits. It occurs partly as a fine-grained, greyish-black rock, containing in places dolomitized crinoid ossicles. Less commonly, according to Redlich, ossicles consisting of magnesite are found, while elsewhere similar crinoids are found in their unaltered condition as almost pure calcite. Redlich attaches much importance to these facts as indicating that the magnesite of Veitsch and similar deposits owes its formation to the replacement of limestone by solutions rich in magnesium bicarbonate. Weinschenk holds a somewhat similar view, but whereas the latter thinks the magnesium solutions escaped from intrusive granites, Redlich is of opinion that the solutions were derived from basic intrusions corresponding to the diabase tuffs and other basic rocks which are so abundant in this region of the eastern Alps. Rumpf held the view that the magnesite was of sedimentary origin and that it was precipitated from the water of hot springs with the mud that accumulated in shallow depressions of the floor of a warm sea. Kern holds a somewhat similar view, and attributes the existing crystalline condition to thermal metamorphism.

In addition to the fine-grained dolomite, the Veitsch magnesite deposit contains a large amount of coarsely crystalline and yellowish-white masses of dolomite. Large cleavage fragments of 10 to 20 cm. edge are obtainable from these masses of coarse-textured dolomite which are enclosed in the Veitsch breunnerite. Such included lumps of dolomite are naturally regarded as objectionable by the quarrymen, and have to be eliminated as far as possible either by cobbing in the quarry, or in subsequent dressing operations, as otherwise the product obtained would contain too much lime. The colour of the dolomite lumps helps the quarrymen to detect their presence.

According to Cornu, dolomite occurs in yet another way in the Veitsch magnesite deposit, namely, as crystals lining the cracks and cavities in the rock; these crystals show zonal bands of iron oxide and pyrite, the pyrite granules being largely oxidized. Associated with the dolomite crystals in these cracks and cavities are small crystals, insignificant in total amount, of quartz, calcite, aragonite, pyrolusite, and pyrite.

In view of the intimacy of the association of dolomite and breunnerite at Veitsch, one might expect that the dolomite would be largely ankeritic. This does not seem to be the case. Analyses of the dolomite show that it is fairly steady in composition and contains only 1 or 2% of iron carbonate. It is fortunate that this is so, for if the dolomite were largely ankeritic, it would be difficult if not impracticable to keep down the lime percentage in the sintered product. The elimination of fairly pure dolomite from breunnerite in dressing operations is an easy matter, whereas the elimination of normal ankerite would be practically impossible.

Lime is regarded as an objectionable ingredient in calcined magnesia, and efforts are made to keep its percentage as low as possible in the sintered product. Austrian sinter usually contains a variable but small percentage of lime, which may be safely attributed to the presence of dolomite, perhaps slightly ankeritic, in the raw material.

According to J. Hörhager (*Stahl und Eisen*, June 15, 1911, p. 955) and A. Kern (already quoted) the quantity of waste rock obtained in quarrying may amount to about two-thirds of the total bulk of the rock. The freshly-quarried material is cobbed to free it as far as possible from coarse fragments of impurity such as schist, dolomite, and quartz, and the lumps are sorted. The cleaner portions of the rock are reduced to pieces about head-size. Less pure material has to be broken into smaller pieces, of fist-size, and its dressing involves a considerable loss of magnesite in the form of fragments smaller than nut-size, which are too small to be burned in shaft kilns. The raw magnesite thus obtained in the quarries at Sattlerkogels is readily transported by aerial ropeways and shoots to the sintering kilns at the foot of the hill.

The sintering temperature varies from 1,400°C. for breunnerite containing a considerable percentage of iron oxide to 1,700°C. for magnesite poor in iron oxide; but, however easily the material sinters it is, according to Hörhager, desirable to carry the temperature up to at least 1,500°C., and this temperature seems to be exceeded as a rule in Styrian shaft kilns.

According to L. C. Morganroth (*Bull. Amer. Inst. Min. Eng.*, 1914), kilns of the rotary type have been installed at several places in Austria, powdered coal being used as fuel, but they suffer from the disadvantage of yielding a larger percentage of fines.

Sintering does not destroy the rhombohedral form of the magnesite fragments, and a microscopical examination of the powdered sinter shows clearly the characteristic texture that has been so well described by Cornu.

According to Hörhager the amount of fuel required to sinter Austrian magnesite is variable, and depends on the amount of ferrous carbonate present; but with good flaming brown coal having a calorific value of 6,000 calories, the amount of coal required is from 0·3 to 0·4 tons per ton of sintered magnesia produced. Kern puts the fuel requirement at 0·5 ton of brown coal (calorific value 4,000 calories) per ton of sintered magnesia produced.

The crushed sinter, as a rule, requires to be further dressed to eliminate impurities, for these are far from having been completely removed before sintering. For this purpose the grains are classified mechanically. Much of the caustic lime or calcined dolomite falls to dust and is easily eliminated in the finest screenings. The coarser grains are readily dressed by hand-picking, the light-coloured and therefore readily-distinguished impurities, such as talc, calcined dolomite, and tridymitized quartz being easily removed. The less coarse material is presumably in large part marketed in a comparatively impure condition, or otherwise requires to be treated magnetically to remove particles of schist, silica, calcined dolomite, and other impurities that are magnetically non-permeable. This magnetic treatment, which involves much waste, adds considerably to the cost of the material, and is presumably only carried out when it is necessary to concentrate the sintered magnesia and thus secure a more refractory product.

In addition to the sintering and dressing plant near

Veitsch, there are works at other localities in Styria, including those at Breitenau and Trieben. There are also works at Eichberg near Gloggnitz, in Lower Austria.

At Veitsch, transport of the refined sinter from the kilns to the goods depôt at Wartberg station is effected by an aerial ropeway over four miles long. The works at Breitenau are situated at the foot of the Hochlantsch (5,700 ft.), where terrace-quarrying and other working conditions closely resemble those at Veitsch and Eichberg. The Trieben works are near the station at Trieben, and are some three miles from the deposits at Sunk where the magnesite is quarried. The deposit at Radenthein has been worked since 1908 by American capital, and from that date down to 1915, large quantities of sinter were shipped to Philadelphia, New Orleans, and New York.

The oversea exports of sintered magnesia from all these works in Styria and other parts of Austria were shipped at the port of Trieste.

The Austrian magnesite formation stretches eastward beyond Vienna into Northern Hungary, where large magnesite deposits are quarried between Jolsva and Nyustya in the Gömör district. These northern Hungarian deposits have much in common with the Austrian, and in spite of their great distance inland from the Adriatic there were considerable oversea exports in pre-war days from Fiume, to which port they were railed some 360 miles for shipment to various parts of Europe and America.

A factor of much economic importance in the magnesite industry of Austria-Hungary is the abundance and accessibility of brown coal which is used in the sintering kilns. If to this we add the further considerations that the deposits are large and easily quarried, that they are within easy reach of transport facilities, and that labour is cheap, we see that Austrian magnesite mining has all the prime essentials of a successful and enduring mineral industry. It is necessary to give due prominence to these considerations if we wish to understand the success that Austrian magnesite mining has achieved in the past, and the competitive pressure it is likely to exert in the future.

There are numerous occurrences of breunnerite in the form of scattered small crystals in talc-schists in various other parts of Austria, but such occurrences cannot be economically worked. Only the massive deposits of the Veitsch type can be quarried and worked at a profit, and even some of these are unable to compete with the largest and most favourably situated deposits.

Canada.—Breunnerite occurs in various parts of Canada. Occurrences were reported a long time ago (*Report of Progress to* 1863, *Geology of Canada*, 1865) in the Sutton and Bolton townships of Brome County, Quebec. On the twelfth lot of the seventeenth range of Sutton the mineral forms a band a foot thick; it is associated with chrome mica, dolomite, and steatite in grey mica schists. A fairly pure and slightly coloured fragment of this breunnerite gave 83·35% of magnesium carbonate, 9·2% of ferrous carbonate, and 8·03% of insoluble matter. An occurrence on the seventeenth lot of the ninth range of Bolton is stated to be a bed twenty yards in width, lying between steatite and impure serpentine. A sample of this gave 59·13% of magnesium carbonate, 8·32% of iron carbonate, and 32·2% of insoluble matter, which consisted almost wholly of quartz.

Of other breunnerite occurrences in Quebec, mention may be made of that described by B. J. Harrington on the fifteenth lot of the first range of Melbourne in Richmond County (*Geological Survey of Canada*, 1874–75). The breunnerite is scattered through serpentine in the form of small irregular crystalline masses of a pale brown colour, and constituted 15½% of the specimen examined by Harrington. It gave on analysis: magnesium carbonate 82·23%, ferrous carbonate 14·84%, calcium carbonate 1·93%. The serpentine matrix in which the breunnerite is embedded showed the following composition: silica 42·79%, magnesia 36·54%, ferrous oxide 6·05%, manganese oxide 0·12% chromic oxide 0·29%, nickel and cobalt oxides 0·37%, water (by ignition) 13·37%.

L. W. Bailey and G. F. Matthew record the occurrence of a vein of magnesite several feet wide in association with chloritic schist on the bay shore of St. John County, near West Beach, New Brunswick (*Geol. Surv. of Canada*, 1870–71). R. G. McConnell (*Geol. Surv. of Canada*, new series XI) found ferruginous crystalline magnesite abundantly in the neighbourhood of the Big Salmon River, just below Island Lake, Lewes River, in the Yukon District. This magnesite, which is associated with chromite and chrome mica, forms bands up to 50 ft. thick in a series of slates, schists, and serpentines. Another occurrence of a similar type was found by McConnell 300 miles northwest of the foregoing locality, on the east side of the Yukon River about 1½ miles above the Indian River. More recently D. D. Cairnes has reported the occurrence of numerous beds of magnesite up to 10 ft. or more in thickness intercalated among slates and dolomites at various places on the Stony Fork of the Black River, Yukon River. These various occurrences in the Yukon area, like many other Canadian occurrences, are too remote from transport facilities to be of any economic importance at present, but they are of much interest as showing the widespread distribution of the mineral in Canada.

India.—An occurrence of breunnerite at Huliyar in the State of Mysore, India, has been described by Sir Thomas H. Holland (*Mem. Geol. Surv. India*, vol. 34, pt. I). The Huliyar rock consists of breunnerite crystals, varying in size from small granules up to crystals of an inch across, lying in a dark greenish-grey, fine-grained matrix of talc and picrolite. Magnetite in the form of disseminated granules, or as patches and bands of dust, is present both in the breunnerite and the matrix. The breunnerite encloses also occasional shreds of talc and picrolite, and granules of pyrite. The specific gravity of a large piece of rock was found to be 2·95, that of the matrix 2·84, while that of the breunnerite was 3·17. The sample examined showed a mixture of 35% of breunnerite and 65% of matrix. The relation of the Huliyar deposit to the surrounding crystalline schists could not be ascertained, but Sir Thomas Holland presumes that it is a metamorphosed peridotite intrusion, and that the formation of the breunnerite is due to the action of carbon dioxide on the rock immediately, or at any rate very soon, after intrusion. He compares the deposit with that at Salem, points out that quartz impregnated with carbon dioxide is commonly associated with the peridotite intrusions of this region, and shows reasons for attributing the formation of the magnesite deposits generally to the action of magmatic water and carbon dioxide. He suggests that the water and carbonic acid which caused the metamorphism of the Huliyar deposit were held in the peridotite magma at the time of intrusion, and that they did their work of transformation in the last phase of the intrusive activity, being liberated from the magma after the olivine had mostly crystallized out. There appears to be no information available as to the extent of this deposit, but the nature of the rock is such as to suggest that the mining and dressing costs would be prohibitive.

United Kingdom.—Occurrences of breunnerite in talc-schists have been reported to occur in various parts of the British Isles, as at Norwick Bay, Unst, Shetland Isles, where the conditions of occurrence appear to be of the normal type. None of these deposits in the British Isles is known to be of any considerable size, and so far as can be judged from descriptions available, the type of rock is such that, even if the deposits were large, the costs of dressing the raw material would be prohibitive. It can hardly be said, however, that British occurrences have received the attention which, in view of present conditions, they appear to deserve, and a fuller description of the areas where they occur seems to be desirable.

SPATHIC MAGNESITE.—Under this heading it is convenient to include those crystalline magnesites in which the magnesium carbonate is free from admixture with ferrous carbonate, or contains no more than 5% of this constituent. These spathic magnesites frequently show a saccharoidal texture and resemble crystalline marbles. Calcite, dolomite, and magnesite all assume this particular texture, and often bear a very remarkable and delusive resemblance to each other, so much so that only by careful tests can their identity be established. It is well worth while to emphasize this fact, for no specimen of the saccharoidal-marble type should be regarded as a limestone, dolomite, or dolomitic limestone without definite proof of identity. The specific gravity test, judiciously applied, is one of the simplest and best, and is readily confirmed by solubility and other chemical tests. The specific gravities of pure crystalline calcite, dolomite and magnesite are respectively about 2·72, 2·87, and 3·01. The associations in these spathic types are usually calcite with dolomite, and dolomite with magnesite. A specific gravity between 2·75 and 2·85 therefore indicates a dolomitic limestone, whilst one between 2·9 and 3·0 indicates a dolomitic magnesite.

A striking instance of the caution needed in dealing with such samples was experienced some years ago by the writer when examining specimens of white crystalline "limestone" from Ceylon. Two of these were identical in texture, and to all appearances in mineral composition also. Both contained small granules of apatite and flakes of graphite, which are of common occurrence in such rocks, and so far as appearances could be trusted they seemed to be identical. The carbonate portion of one sample, however, had a specific gravity of 2·87 and proved to be pure dolomite, while the carbonate of the other had a specific gravity of 3·01 and proved to be almost pure magnesite.

Recent work in areas where metamorphosed dolomites occur has shown that saccharoidal magnesite occurs more frequently than might have been supposed, and it is especially worthy of note that the spathic magnesites of both Quebec and Washington State were used as marbles for building purposes prior to their recent extensive development and use as sources of refractory magnesia.

Canada.—Among the most important examples of spathic magnesite at the present time are the deposits near Calumet in Argenteuil County, Quebec, which were first observed in the year 1900, and have been described at length by M. E. Wilson in a memoir issued recently by the Geological Survey of Canada. (Magnesite deposits of Grenville District, Argenteuil County, Quebec, Memoir 98, *Dept. of Mines, Canada*, 1917). The chief localities are in the townships of Grenville and Harrington, where magnesite occurs in a formation known as the Grenville series, which is of early Pre-Cambrian age. Work was commenced on these deposits in a small way in 1907, at a locality about 12 miles from the Canadian Pacific Railway, the nearest station being Calumet. The Grenville series is made up of metamorphosed sedimentary rocks consisting chiefly of gneisses, quartzite, and crystalline limestone. Associated with these is a series of intrusive pyroxenic igneous rocks (the Buckingham series) ranging in composition from syenite to gabbro and pyroxenite. The dominant intrusive rocks of the district, however, are huge bosses of gneissose granite and syenite of later Pre-Cambrian age than the rocks of the Grenville and Buckingham series, into both of which they intrude. Even this does not complete the record of the changes that took place during Pre-Cambrian times in this remarkable Eastern Canadian patch of the earth's crust, for there are still later intrusions of dolerite and granite the geological relations of which have led the Canadian geologists to regard them also as Pre-Cambrian. With the exception of a small area occupied by older Palæozoic rocks, and a superficial covering of Pleistocene detritus on the lower ground, the Grenville district is occupied entirely by Pre-Cambrian rocks, and it is in the oldest of these, the Grenville series, that the magnesite occurs, as a metamorphic rock associated with dolomite and serpentine, usually in close promimity to the pyroxenic rocks of the Buckingham series. The rocks of the Grenville series have offered less resistance to denudation than the gneissose granites, and the larger valleys of the district have therefore been carved out of the former rocks. It is in these valleys that the magnesite deposits are found cropping out in the form of ridges which pierce the Pleistocene sands and clays, and which may be as large as 1,000 ft. long and 300 ft. wide.

The rocks of the Grenville district have suffered extensively from crumpling and deformation, as a result of which well-marked foliation and lenticular structure have been developed. The magnesite itself occurs in lenticular masses and shows a banded appearance due to the streaky distribution of the serpentine it contains. The intimacy of association between the magnesite and the serpentine is shown by the manner in which such streaked masses of magnesite pass gradually into massive serpentine. Still more intimately associated with the magnesite is the mineral dolomite, which is almost invariably present in scattered irregular pieces through the mass; the dolomite is also present in the form of separate lenticular masses. Other minerals found associated with these magnesite-dolomite-serpentine masses of the Grenville series are diopside, phlogopite, quartz, talc, pyrite, zinc-blende, magnetite, and graphite. Diopside is particularly abundant near the contact of the magnesite with the Grenville quartzite, which adjoins it in places. Masses of quartz have been found in the magnesite at one locality, and it is thought that these may be portions of Grenville quartzite that have become incorporated in the magnesite. Phlogopite and talc are associated with the serpentine and diopside. Grains and cubes of pyrite occur commonly scattered through the serpentine and dolomite, but are not usually found in the magnesite; and zinc-blende is occasionally associated with the pyrite. Magnetite is found as octahedral grains in the dolomite. Graphite is scarce, and, as is usually the case in such rocks, is disseminated in the magnesite in the form of fine crystalline flakes

Wilson attributes a metamorphic origin to the Grenville magnesite, and concludes that it has been formed by the replacement of the limestone member of the Grenville series through the agency of magnesia-rich solutions. According to him the probable order of events in the formation of the deposits was as follows: (1) the silication of limestone to diopside and the formation of phlogopite in places; (2) formation of serpentine in places; (3) replacement of limestone by dolomite; (4) replacement of dolomite by magnesite; and (5) the alteration of diopside to serpentine.

Some idea of the magnitude of certain of the Grenville district deposits may be gathered from the dimentions recorded for Outcrop No. 3, Lot 15, Range XI, in Grenville township. This deposit has a horizontal extent of 30,0C0 square feet, a proved average depth of 122 ft., and is estimated to contain 60% of magnesite. The estimated quantity of magnesite available in this particular deposit is 187,500 tons, and 71 samples of magnesite taken from the deposit show amounts of lime ranging from 5 to 15%.

The Grenville magnesite is cobbed in the quarries to remove the impurities so far as this is economically possible. The colour and appearance of the material assists the quarrymen in their hand-dressing operations. The dolomite is dull-white or coarsely crystalline. Cream-white to glistening magnesite of medium to fine-grained texture contains as a rule less than 7% of lime, whereas the purer white variety contains rather more lime, up to 11 or 12%, and the grey varieties may contain still more lime. A laboratory test is stated to have shown that, after calcination, the dolomite slakes to a smooth paste and can be washed away, leaving a residue of purer magnesite.

Although dolomite is invariably present in the deposits, it has been shown by diamond-drilling and other development work that there is a large amount ot magnesite containing on the average not more than from 7 to 10% of lime.

Wilson's summary shows the following amount of magnesite and magnesite-dolomite in sight on various properties at the time he examined them: Magnesite with less than 12% lime, 686,900 tons; magnesite dolomite with more than 12% lime, 483,700 tons. Further exploration in the Grenville district is likely to result in the discovery of other deposits, and a large increase in the proved reserves of magnesite. According to Wilson it is probable that extensive masses of magnesite occur beneath the superficial covering cla in the low-lying parts of the district. A deposit of spathic magnesite near Orangedale, Inverness county, Nova Scotia, was described recently. (*Summary Report Geol. Surv. Canada*, 1916). A trial output of 30 tons of this has been tested by the Nova Scotia Steel & Coal Company. An analysis showed 90·8% $MgCO_3$, 1·6% lime, 1·71% ferric oxide, 1·01% alumina, and 0·3% silica.

(*To be continued*).

TUNGSTEN DEPOSITS IN SOUTH DAKOTA.

The mining of tungsten ores in the United States was much stimulated by the war, and both old and newly discovered deposits have been actively worked. Among the interesting producers are those in the Lead district, Black Hills, South Dakota, operated by the Homestake Gold Mining Company. We extract a description of these mines from Bulletin No. 12 of the South Dakota School of Mines, reference to which is made in another part of this issue.

The deposits worked by the Homestake company are all near the base of the flat-lying Deadwood formation of the Cambrian series and are found intermittently over a total area of perhaps 15 acres. The formation within this area consists of a thin basal conglomerate and quartzite, on the average less than 5 ft. in thickness, lying upon vertical schists of Pre-Cambrian age. The quartzite is overlain by from 30 to 36 in. of impure partly silicified dolomite, containing thin shale layers, and this by calcareous shales. In places the quartzite and conglomerate are absent, and the dolomites lie directly upon the schists. Upon the shales nearby lies a thick sill of intrusive rhyolite porphyry and some of the middle Deadwood formation, but in the area of the tungsten deposits the igneous rock as well as the medial and upper beds of the Deadwood formation have been eroded away. The tungsten ores occur chiefly as replacement deposits in the lower dolomite, but to a small extent also in thin shale layers within the dolomite, also in the quartzite and as cement in the conglomerate. In the shale, quartzite, and conglomerate the tungsten minerals have probably replaced only the calcareous portions. No tungsten has been found at this point in the Pre-Cambrian rocks, nor in the Deadwood formation above the lower dolomite.

In form the ores are largely irregular tabular masses from a fraction of an inch to 2 ft. in thickness and with a width, parallel to the bedding, of from an inch to as much as 53 ft. The ore-bodies branch, pinch, and swell, and in places appear on the breast of the stopes as isolated kidney and lens-shaped masses of varying width and thickness. Within a single dolomite layer 30 in. in thickness as many as 4 or 5 horizontal ore-bodies occur, separated in some cases by thin shale members. In the calcareous shale members of the dolomite beds, in places some replacement has occurred, but the form and general nature is not essentially different from the bodies occurring in the dolomite proper and are in most cases merely extensions of the latter. Within the quartzite the tungsten occurs much less commonly and in masses of much smaller extent than in the dolomite, but in general takes the same forms. Only a very few occurrences of tungsten have been found in the conglomerates where it fills the spaces between the pebbles that probably had been previously occupied by calcareous cement. The shapes of the bodies are irregular and their total volume small. The ores follow lines of fracture called verticals and extend laterally from them as a centre. The verticals are perhaps more numerous parallel to the underlying schist layers than in other directions. One vertical in the Harrison mine was followed for a distance of fully 500 ft., along which mineralization had taken place for an average width of about 30 ft. throughout its entire length. In most cases the mineralization is as variable in extent along the strike of the verticals as the laterals are variable in width and thickness, and it is very difficult to give anything like an average for the length, width, thickness, or number of ore-bodies within a single dolomite layer.

The tungsten ores in the Homestake property are everywhere intimately associated with silicious gold ores of the Deadwood formation, but there is by no means tungsten ore wherever gold occurs. J. D. Irving regarded the tungsten as merely a basic phase of the gold ores and not as a separate and distinct deposit. The gold ores where unweathered consist of a hard, brittle, grey rock composed largely of silica, carrying pyrite, barite, fluorite, and gypsum. It is largely within these silicious ore-bodies and to a lesser extent around their margins and as cappings over them that the tungsten ores occur. In the tungsten areas the silicious gold ores are largely oxidized and are stained brown with oxide of iron and in places black manganese dioxide. In striking contrast to these soft brown oxidized gold ores, the portions bearing tungsten show very little effect of the weathering and are practically everywhere hard, brittle, bright, sharply defined masses. Where the silicious gold ores are unoxidized the line of separation between the tungsten-bearing portions and the gold ores are in places sharp, while elsewhere they grade by imperceptible variations into each other.

The ore varies from a dense heavy black rock with a fine texture of nearly solid wolframite grains, to a grey quartzose rock containing small black shiny specks of the mineral. The wolframite in these phases does not commonly exhibit crystal boundaries but shows small flat metallic cleavage surfaces. Individual grains are rarely more than $\frac{1}{32}$ in. in diameter, but recently ores have been found that contain individual curved cleavage surfaces of more than an inch in diameter. The mineral is uniformly jet black and exhibits a brilliant metallic lustre on cleavage faces. A considerable amount of black manganese dioxide in places has impregnated the rock and has often been mistaken for ore. It is easily distinguished from the wolframite by its dull lustre, its lack of cleavage, and its lighter weight. Barite in well formed tabular crystals, grouped in interpenetrating and in radiating aggregates, is a prominent feature in places. Cavities of various sizes and forms lined with well formed wolframite crystals and others lined with druses of barite or quartz are not uncommon. The wolframite crystals show knife-like edges and somewhat resemble the form of axinite. For the most part the crystals are very small, the largest attaining a diameter of scarcely more than $\frac{1}{4}$ in. Small rounded aggregates of scheelite crystals resembling drops of honey in form and colour frequently occur on the wolframite druses. This scheelite is regarded as most probably secondary. All analyses of the ore have shown the ore minerals to be wolframite low in manganese with small amounts of scheelite. Thus a typical carload of concentrate containing 60 to 61% WO_3 would probably carry between 3 and 4% manganese, with about 17% iron and 1% calcium, a minute amount of phosphorus, and not more than a trace of tin or copper. The ore concentrated at the mill for the past few years has averaged nearly 3% WO_3 and \$4·00 in gold per ton. The gold values recovered have been sufficient to pay most of the costs of mining and milling.

The deposits of tungsten on the property of the Wasp No. 2 Mining Company are in all essential respects similar to the deposits at the Homestake. On the property of the Bismarck company lying adjacent to and north of the Wasp No. 2 mine, wolframite deposits occur with gold ores as replacements in the lower dolomites and to some extent in the basal quartzite of the Deadwood formation, as in the Wasp and Homestake. At the Etta mine the geological relations are very similar to those existing at the Wasp No. 2 and Bismarck. The property lies north-north-west of the latter at a distance of about $\frac{3}{4}$ of a mile. Rhyolite porphyry occurs in dykes and sills and has caused considerable displacement of the lower beds of the Deadwood formation probably along faults. Ores of gold as well as the tungsten ores occur in intimate association with the porphyry. Specimens obtained from the property contain wolframite in important quantities and appear similar in every respect to average samples from the Wasp, Bismarck, and Homestake.

With regard to the origin of tungsten deposits the late J. D. Irving believed that they were formed through the gradual replacement of the country rock by wolframite. This he held to be clearly indicated by the character of the ore, the nature of the beds in which it is found, and the metasomatic origin of the ores with which it is inseparably connected. First, the wolframite itself is filled with cavities of irregular form and distribution such as are almost always to be observed in ores formed by replacements where the aggregate volume of the mineral introduced is smaller than that of the original rock; secondly, the beds in which the ore occurs are composed chiefly of magnesian limestone, often quite impure, it is true, but of a prevailingly soluble character; thirdly, wolframite is an integral part of shoots of silicious gold ore, the metasomatic origin of which has been conclusively proved by careful microscopic study. As regards the source from which the tungsten minerals have been derived, no positive conclusions can be formed; but the relation of the deposits to the geology and to the other ore-bodies of the neighbourhood seems to furnish some evidence as to their derivation. They are found at two rather widely separated localities on the west side of the outcrop of the Homestake ore-body. Along this line there has taken place, first, the heavy mineralization of the Algonkian rocks, which has produced that well known ore-body; secondly, the mineralization of the Cambrian above resulting in the formation of silicious gold ores, which are richer and contain a more varied assortment of secondary character than ores of a similar character away from the Homestake lode; and thirdly, the formation of the wolframite-ores themselves. It seems, then, that the line of strike of the Homestake lode is also a line along which mineralization has been both varied and unusually intense. During this extensive mineralization, the circulation of waters capable of dissolving the metallic contents of the surrounding rocks must have been active. That these waters were, in the case of the silicious ores, and hence in the case of the wolframite, ascending waters is proved by the concentration of these deposits beneath impervious beds. It is therefore not unreasonable to suppose that if wolframite occurred in the Algonkian rocks at some point below the deposits now worked, just as it occurs in its normal relations at other points within the Hills, the action of ascending thermal waters upon this material should have given rise to the mineral-bearing solutions which carried the wolframite up to its present position, and, there encountering rock sufficiently soluble to admit of metasomatic interchange, should have redeposited their metallic contents.

Up to the year 1915 practically all of the Black Hills tungsten ore sold was marketed in the form of hand-picked ore. Since that time by far the greater part of the product has been concentrated. At the Homestake mill during 1917, 254 tons of concentrates of various grades were produced from approximately 7,200 tons of ore that averaged from 2 to $3\frac{1}{2}$% WO_3. The percentage of recovery approximated 73%. In addition to its tungsten content the ore carried on the average between \$4·00 and \$5·00 per ton in gold, which when extracted was sufficient to pay for the treatment of the ore. The ore is delivered to the mill in cars, teamed from the mine some distance away. At the mill it is dumped into bins, from which it passes to a 5K gyratory crusher. The discharge from the crusher is carried by means of a belt conveyor to the battery bin. Five 900 lb. stamps and two small ball-mills complete the crushing and fine-grinding equipment. The stamps, similar to those in the company's gold mill, have a crushing capacity of approximately 20 tons per 24 hours. These crush the ore to pass a screen, 2 by 12 mesh, the openings being 0·023 by 0·052 in. The pulp from the battery on passing through the screen flows over a 4 ft. amalgamation plate, to recover any free gold present in the ore. The concentrating equipment consists of one Wilfley sand table and three Deister slime tables. The discharge from the plates passes to a classifying cone, from which the coarse product is sent direct to the Wilfley table. The following products are made by the Wilfley: (1) a 70% WO_3 concentrate, (2) a 50% WO_3 concentrate, (3) middling, and (4) tailing. The middlings are sent to two small ball-mills for re-grinding. The overflow from the classifying cone is treated in two dewatering cones, and the thickened product is treated on the first Deister slime table, where a 60% WO_3 concentrate, middling, and tailing are produced. The middling together with the re-ground product from the ball-mills is treated on the two remaining Deister tables. These last tables make a 35% WO_3 concentrate, a middling, and a tailing. The middling product is returned to the ball-mills The tailings from all the tables are sent to the company's gold mill where they join the gold ore tailing and pass with it over amalgamation plates, through the re-grinding plant, cyanide plant, etc., effecting thereby the recovery of a large percentage of the remaining gold. The four grades of concentrates produced in the tungsten mill are separately dried on steam driers and sacked for shipment. During the 3½ years from January, 1915, to June, 1918, the output of picked ore and concentrate at the Homestake mill was about 650 tons. The outlook since the Armistice is not at all clear.

CONCENTRATION OF TIN SLIME.

At the February meeting of the Institution of Mining and Metallurgy, Professor S. J. Truscott presented additional reports on his investigations into the concentration of tin slime on Cornish frames undertaken with the object of ascertaining whether any improvement can be made in the percentage of recovery. These reports are in the nature of supplements to the report presented at the meeting held in November, 1917, and they deal with the relative efficiency of fluted and plane surfaces, the relative advantages of rapid and gradual enrichment, and the desirability of re-grinding; also, an account is given of tests at Dolcoath, and of experiments with stepped beds. The most important conclusion made by Professor Truscott is that by rapid enrichment the percentage of recovery of slime may be increased by about 25%, and the total recovery by say 5%. We quote herewith his résumé of the results of his investigations, and we refer to the subject in our Editorial columns.

FRAME WORKING.—It is considered that the following points concerning the factors governing frame working have been established:

Nature of Surface.—The plane surface, and particularly that of wood, does better work than the fluted surface on ordinary slime. The finely fluted surface is the better of the two on re-ground material.

Bed-length.—On ordinary slime a bed 3 ft. in length does twice as good work as one of 6 ft. The longer bed requires a greater rush to get rid of the gangue in the time allowed. On re-ground material even a shorter length of say 2 ft. could be used with advantage.

Inclination.—The inclination should be such that during feed about 80% of the gangue is removed.

Washing.—Washing to remove some of the little remaining gangue is effective, raising the value of the concentrate at an insignificant sacrifice of recovery. It is, on the other hand, of diminished service when a large proportion of the material has settled during feed.

Rate of Feed.—With ordinary slime the best rate of feed appears to be about 4½ tons per day for an 18 ft. concave round frame and 15 cwt. per day for a 6 ft. flat frame. At a rate much greater than this too great a drop in recovery would occur, while at a lower rate there would be an unnecessary drop in capacity. With re-ground material the above-mentioned rate may be increased substantially and perhaps doubled.

Consistency of Feed.—The liquid-solid ratio of the feed is best kept about 10 : 1. No greater ratio is required for effective concentration, while within limits a smaller ratio has the advantage of permitting a heavier rate of feed without causing a rush.

Duration of Feed.—The duration of feed, that is, the time taken to load the frame is best kept about 4 minutes; the flat frame should accordingly be flushed at that interval, while a round frame should make a revolution in about 4½ minutes. A shorter duration would not give the gangue particles time to travel down the bed.

Regularity of Feed.—To the above factors must be added the need for regularity in feed. Such regularity can only be given by pyramidal or conical settlers with pointed bottom discharge.

POLICY.—As a result of the whole series of tests, modifications of two fundamental factors in policy, namely, the rate of enrichment and the amount of re-grinding, have suggested themselves.

Rapid Enrichment.—Employing the working conditions just specified, the first frame concentrate from a slime feed assaying 10 lb. or more would be of such increased value and reduced bulk that its further dressing could be justifiably and advantageously undertaken in buddles. Buddles possess in their mineral surface the best possible surface for catching both fine and granular tin, while at the same time the products are sized so that the next buddling is of sized as well as graded material. Moreover, they are worked in a closed circuit from which only top water flows away, the solid products remaining in a comparatively dry state. The loss of tin in buddle treatment is accordingly small. With re-ground material the first frame concentrate from a feed assaying even lower than 10 lb. could go at once to the buddles or even to the calciner since from such material a higher rate of enrichment is obtainable. On such lines the ratio of enrichment in the primary slime treatment would be generally 6 : 10 in the place of 2 : 4 as at present, and the policy would be that of rapid enrichment in the place of the present practice of gradual enrichment. It is considered the tests indicate that by this policy the present recovery could be obtained with one-half the present frame area, and that the area thus set free, applied to the re-treatment of the tailings, would improve the slime recovery 25% and the total recovery, say, 3·5%. Beyond this, if the present frame area is as much as the mines can reasonably accommodate, it might not be convenient for them to go. On account of the diminished value of the material any further recovery would require much additional frame area. Such work, rightly or wrongly, is largely left to the streamers, who from the large bulk at their disposal are repaid with a low percentage recovery. Extending the principle of rapid enrichment to their working, the total recovery of tin in Cornwall would be improved, say, 5%. With the passage of time it has been the experience that the tin in the available rock has become finer and finer, and it seems more than likely that in the future slime tin will bulk larger than it does now. Any endeavour to improve slime recovery is accordingly doubly justified.

COMPLETE FINE GRINDING.—Repeatedly in the tests the little difficulty experienced in catching the tin resulting from fine grinding was remarked. This fact was particularly expressed in the treatment of reground sand residue from South Crofty, when, at a rate of feed equivalent to 10 tons per day on a standard round frame and from material assaying as low as 5 lb., a recovery appproaching 60% was obtained in a concentrate assaying 100 lb. The sand residues in Cornwall will generally assay about 5 lb., from which by framing followed by buddling it could be expected to recover 2 lb. per ton in the form of marketable concentrate. Such an amount would leave a profit with tin as low as £150 per ton. Assuming the sand to amount to 60% of the whole pulp, and the present recovery in Cornwall to be about 20 lb. of tin per ton, that recovery would be increased about 6%. On these lines the whole of the ore would, first or last, receive a frame treatment. For the re-ground material, shaking tables would not be so efficient and are more expensive.

The amount of re-grinding at present done in Cornwall is, generally speaking, limited to the middling products. It is suggested that this re-grinding should be extended to embrace all the sandy material and grind it to pass 120 mesh.

The losses in the past have not been due to excessive comminution; they have rather been due to the natural state of fine division of some of the cassiterite. On the other hand, the loss due to tin passing away imprisoned in the sand has not been fully appreciated. Witness the grading analysis of the Giew mill tailing, which showed that 50% of the tin was lost in the granular material. The fact that the sand was equally responsible for the tin lost has been obscured by the notoriously low percentage recovery from the slime. Moreover, this sand as it goes away invariably carries with it granular slime tin which has escaped the tables and been discharged from the sand pits or separators. This and the bulk of the imprisoned tin would be recovered if all the sands were ground and framed as slime.

Where the ore contains little or no wolfram or arsenic, it is possible that complete fine grinding might, with advantage, take place without previous removal of the coarse tin, leaving that, as well as the fine tin, to be recovered by frames. The obvious advantages of such a course would be the greater simplicity and lower cost of the plant; a disadvantage would be the finer condition of the concentrate. With respect to recovery, the tests made in the laboratory indicate than an improved recovery would be obtained from such a treatment.

In addition to the above-mentioned laboratory tests, complete fine grinding finds support in the scale at which re-grinding is being used in the recovery of tin from old tailings at the milling plant of the Cornwall Tailings Co. Any further tests would unavoidably have to be done on a large scale.

HISTORY OF THE TONGKAH HARBOUR DREDGING ENTERPRISE.

Readers of the Magazine will recollect the incidents in connection with the Tongkah Harbour Dredging Co., the Australian company formed in 1906 to work tin gravels in the Western Siamese States. The early history of this enterprise has never been fully written, nor has that of the Renong, an English company, the other candidate for first honours for tin-dredging in the East. In the *Industrial Australian and Mining Standard* for October 3 and 10, the founder of the Tongkah Harbour enterprise, Captain E. T. Miles, of Melbourne, puts on record the history of the early days. We quote him in full.

Much has been said and written at various times on the origin of tin-dredging in Siam and Malaya, most of it erroneous, some with a smattering of truth. Men who were the greatest pessimists, who did their best to block the flotation of the pioneer company, and ridiculed the idea of successfully dredging tin from Tongkah Harbour, have since publicly claimed the credit of being the pioneers of tin-dredging in Siam and Malaya. For record purposes I propose to state a few facts on the origin of the industry.

On the invitation of the late H. E. Phya Raseda, High Commissioner of Western Siam, I went to Tongkah in 1905 to investigate what was then known as the Government Compound, an area of about 50 acres in the centre of the township, on which stood all the Government buildings, comprising the High Commissioner's and the Governor's Offices, Treasury, Mines Office, Gaol, Police Office, etc. This area was practically all that was left unworked of the valley which Chinese had been working for tin for 60 or 70 years. Starting from the foot-hills, they had worked down the valley to the foreshores of the harbour, and by means of a series of cofferdams for a quarter of a mile into the shallowest part of the harbour, leaving unworked the Compound. This latter had been extensively bored by a Government boring gang, under Boring-Superintendent McLellan. I carefully checked the bores, and satisfied myself that this area would average about 2 lb. per cubic yard, but, while the Government had fixed their compensation for removal of buildings at about £20,000, compensation to private owners was left for settlement between the parties, and was consequently an unknown quantity. I pointed out to the High Commissioner that this unknown quantity would be a bar to the flotation of a company in Australia or elsewhere, and advised him to have the value of private improvements assessed and added to the Government's compensation, so that the actual cost could be shown to promoters. This was done some years later, the outcome being that A. W. Palfreyman courageously came to the rescue on the last days of the option and took a huge liability, resulting in the flotation of the Tongkah Compound Co., which has been exceedingly profitable to all concerned. But it must be remembered that at this later period the Tongkah Harbour Co. had been at work for some considerable time, and had demonstrated that ground of similar character to the Compound could be worked for 4d. per yard. Without that knowledge anyone asking the business men of Australia to put up £50,000, plus the cost of a dredge and plant to work 50 acres of ground, would have been regarded as a fit inmate of a lunatic asylum.

At the time of my visit to Tongkah about 600 coolies were, by means of a series of cofferdams, working two open lombongs at least a quarter of a mile out in the harbour, beyond original high-water mark; and while at this time the financial difficulties of the Compound seemed insuperable, the Harbour and its possibilities appealed to my nautical instincts. I feel sure that the ordinary mining engineer would not have tackled the Harbour at that time, for it was more a marine than an engineering problem. Chinese are very jealous of any stranger, particularly a European, going into their mines, but an introduction from the High Commissioner removed all disabilities as far as I was concerned, and I had free access to the workings, and was consequently enabled to ascertain, by personal observation, the number of men employed, the quantity of cassiterite produced daily, and the nature and extent of the karang (tin-bearing gravel). Above all, the mines being dry, I had an opportunity of seeing what no other European has since seen, the character of the overburden from surface to kong (the bottom under karang), and I was convinced that similar clay overburden in the harbour would stand the test of dredging.

Whether Tongkah Harbour could be successfully and profitably worked by dredging depended upon whether, in opening a paddock, the banks would stand, or whether, with the ebb and flow of the tide, together with the ocean swell, the banks would fall in and fill the paddock as fast as the dredge could remove it. Having satisfied myself on this point, the next move was to ascertain how far the deposit extended into the harbour, and whether the depth was within the limits of economical dredging. I borrowed a boring set and put down sufficient bores in the harbour to satisfy myself that the deposit extended at least a mile into the harbour, and that it was of the same value and character as that seen in the open mines.

The problem before me thus was: Can the harbour be worked to pay 15 or 20% interest, and return the invested capital during the life of the mine with 70% concentrate, worth only 8d. per lb.? Metallic tin was then about £125 per ton. I had estimated the cost of working the lombongs by Chinese methods at 1s. 1d, per cubic yard, and concluded that as the same ground could be worked by dredge at about 4d. per yard, there must be a huge profit. Holding this view, I made application to the High Commissioner for a mining concession for the Harbour, but was met with a refusal, on the ground that the working of the mine so far seaward was causing their only channel, which carried all the traffic, to silt up, and the Government had refused the Chinese permission to mine any further seaward on that account. This raised the "dock and channel" question, about which so much was said and written a few years back by ill-informed critics. After full consideration, I undertook, if the Government gave me the sole right to dredge the whole of the harbour (about 6 square miles) to dig a dock and a channel thereto, 20 ft. deep. I made a glowing picture of a dock, with all the gunboats, steamers, and tonkongs discharging at a wharf, instead of lying three miles off and discharging into lighters, and impressed the officials with the advantages, both in cost and convenience. About this time Prince Dameong, then Minister for the Interior, came to Tongkah, and I discussed the possibilities with him, with the result that he instructed me to prepare a draft concession for his approval, and present it at the Mines Department at Bangkok. The original draft I have in my possession, and it is very gratifying to me that it ran the gauntlet of a special commission, which included officials of the highest standing in the Siamese Government, both Siamese and European, and came through without any appreciable alteration from the original text.

It is a matter of history that some years later the Tongkah Harbour Co. compromised with the Siamese Government, and, in lieu of digging the dock and channel, agreed to pay £35,000, spread over 5 years, and do some minor dredging in the boat channel. It is worthy of note that previous to this compromise I had offered the Tongkah Harbour Co. a very large sum for the right to dig the dock and channel, taking as compensation for the work the tin recovered from the area during the operations.

After securing the concession, the feasibility of dredging the harbour profitably was still doubted. At one stage the friends with whom I was associated in the venture discussed the question of abandoning the project, and it was probably the prompt action of a leading Melbourne investor, who has always been foremost in assisting the flotation of these Eastern ventures, that decided the question and retained the concession for Hobart.

As showing the difference between the ambitious flotation schemes of to-day and those of 1906, we essayed to float the Tongkah Harbour Co., pay preliminary expenses, cost of flotation and registration, build a dredge, transport it to Penang, re-erect it there, tow it to Tongkah (180 miles), purchase fuel, provide dwellings for our men, dressing shed, floating plant, spares, etc., and pay salaries during the re-erecting period, with a paid-up capital of only £17,500, to provide which 35,000 shares were issued at 10s. In these days of extravagance this sum would be considered ridiculous, but the fact remains that all the work enumerated above was done and paid for out of £17,500. It is true, however, that during the opening-up period, and before getting down on tin, my bank balance was reduced to 30 dollars credit, while the outstanding liabilities amounted to £200, with nearly two-thirds of a month's wages due, and still no tin. At this stage a Chinese friend, resident in Tongkah, who was a comparatively large shareholder and knew the financial position of the company fairly well, interviewed me, and the following dialogue ensued: "You haven't much money, Capt. Miles?" "I think I have all I need." "Well, I don't think you have; and if you want 10 or 15 thousand dollars, send a chit (note) up to me, and I will send it down." "I have authority to do many things, but I don't think I have authority to borrow money." "No, I don't mean the company; I mean you. If you want the money I will send it to you." "But I might never be able to repay you." "Never mind that; if you can repay me you will; if not, I will forgive you." He left me after getting a promise that if I needed the money I would send for it. It was a kindly and generous offer of assistance from a friend who believed I needed it, in marked contrast with the usual offer of assistance when it is not needed. The assistance, however, was not required, for two days later we were down on tin, and at the end of the month had a nice little parcel in the store which cleared up all outstandings; but it was a close shave. If we had been compelled to make a call before getting down on tin, the Tongkah Harbour Co. would, in all probability, have gone into liquidation, and the dredging industry in the East would have been set back a quarter of a century.

No. 1 dredge was built in Glasgow, transported to Penang, and re-erected at the Prye Dock in 1907. Prince Dameong publicly started the machinery on November 4, 1907. Then came the problem of towing the dredge to Tongkah. No steamship company would undertake the responsibility, neither would any insurance company take the risk. It was the generally expressed opinion of the Europeans that the dredge would never reach Tongkah. One could understand the Chinese and native population, who had never seen or probably heard of such a piece of machinery as a dredge, being sceptical, but the insistence with which the European section of the community opposed everything connected with the dredge and dredging is incredible. It may have been from ignorance, or, more probably, from jealousy of a stranger coming there and supplanting them in an industry which they regarded as their own. The only choice left me was to hire a small steamer, with a native crew, capable, in fine weather, of towing the dredge three miles an hour. The dredge went uninsured, and I had to guarantee the owners of the steamer her full value in case of loss. My son took charge of the dredge and those on board, and I navigated the steamer. For the first twelve hours we had a rough time with a nasty troublesome beam sea; after that we got inside of a chain of islands skirting the coast, and fared better. On the third night, about 10 p.m., we anchored in Tongkah Harbour, having had little food or sleep for three days. We only got the anchor down just in time, for within two hours a gale sprang up from the westward, and blew with hurricane violence for several days. Had it caught us crossing the open sea, anything might have happened; to run back to the islands for shelter would have involved turning round broadside to wind and sea, which, with her top hammer, would have been most dangerous. However, the Miles luck prevailed; we got there without accident, and without insurance. Two days later we were dredging Tongkah Harbour.

The early dredging difficulties were stupendous. There were many things we needed, but, being short of capital, had to wait for them until we could dig them out of the ground. Tongkah at that time had no telegraphic communication, and was served by a small steamer from Penang weekly; there was no engineering shop of any description; even a 3 in. bolt had to come from Penang; the smallest casting took 10 or 12 days, and frequently longer, to reach Tongkah. To get fresh water for boilers we had to tow a punt up the creek on flood tide, wait until the stream was fresh at low water, fill the punt with buckets, and wait again for the next high water to float the punt and tow her down on the ebb. Thus it took two days to get a punt load of water to the dredge. Fuel was another trouble; the natives had been in the habit of cutting wood a certain size and selling it at so much per 100 pieces, and it was with the greatest difficulty that I could persuade them to cut wood suitable for the dredge. Then came the transport. We had nothing but small open sampans to carry 15 to 20 tons of firewood daily to the dredge, and this work occupied the whole 24 hours. On more than one occasion, to prevent the dredge stopping, my sons and I had to turn out at night, load up a couple of sampans, and take them out to the dredge; no other labour was available, and it was a case of stopping the dredge or carting the wood.

The labour troubles were immense. The natives were afraid of the machinery, afraid of working in the dark, afraid of European employers, who had the reputation of treating them badly, and at first positively refused to work on the dredge. By dint of persuasion, kindly treatment, and prompt payment, we got first one and then another, and finally a crew, who soon found that it was not a bad job; they were well paid, not ill-used, and had electric light at night to work by. Fortunately, we had no accidents. If one of them had been killed or seriously injured in the early stages, the dredge would have been doomed as "bad joss." After a time my trouble with the Asiatic employees ceased, and the source of trouble then was the Europeans, some of whom would persist in bullying and ill-treating the Asiatics, and finally I was compelled to insist upon the natives being treated as human beings and not as brutes. On more than one occasion I was obliged to get rid of an otherwise good European because of his treatment of the Asiatic. Under Asiatic custom, all the members obey the head of the family, be he grandfather, father, or elder brother, and so with the head man of the village or the head man of a kongsi. Under their custom, while it was quite proper for me, as towkay of the dredging company, to chastise them if they did wrong, it was improper for any of my subordinates to do so. They will accept chastisement from the head man without a murmur, but resent it coming from anyone else.

One could go on enumerating the difficulties of the early pioneers, which time and circumstance have much changed. In Tongkah now, the manager has quite an imposing residence in the healthiest locality. I lived in a Chinese-built house in which there had been several cases of plague. They have a first-class workshop, with the latest improved up-to-date machinery; an excellent staff, well housed and well paid; club-houses for their amusement, motor cars, motor boats, tug boats, and modern appliances for lifting machinery and other heavy weights; telegraphic communication with the outer world; a bank, large cash balance, and tin at a much higher price than my modest £125; and I have lived to see my optimistic dream of 1905, of the future of dredging in the East, fully realized.

But there is cause for concern in the high capitalization and ever-increasing operating costs of present-day companies, and if the pioneers had been imbued with the extravagant ideas of some latter-day promoters, there might have been no Tongkah Harbour Co., and probably no tin-dredging in the East to-day. But dredging is there to stay until all the workable dredging ground is exhausted. There is little 2 lb. ground left, and not a great deal of ground worth 1 lb. The dredging of the future will be chiefly in ground of under a pound per cubic yard value, and hence after the war it will be necessary to exercise economy in every direction to enable shareholders to get a fair return for their investments.

But it is so much easier to increase than to reduce expenditure; and I fear the enormous earning power of the companies during the war may have created extravagant habits that will be difficult to shake off. Take the item of labour as an illustration. The coolie of 1905 considered himself well paid at 60 cents per day; increases have been periodically made until the best of them to-day get 2 dollars. A Chinese mechanic in 1905 was paid 1·50 dollars; the rivalry and competition between the companies for mechanics accustomed to dredge work is now so keen that these men are offered inducements to go from one company to another, each time at increased rates, until they now get from 4 to 5 dollars per day; and so with Europeans. It is quite a common occurrence to find a man whose passage has been paid from Australia or England on a three years' contract, after a few months' or a year's service, working for another company, which did not provide his passage, at much higher rate. In addition to the increased wages, the numbers have increased to such an extent that there are now employed on and about a dredge 50% more men than was originally considered sufficient to do the work. It will be difficult to alter these working conditions, and the economical dredging of low-grade ground in the future would appear to lie in the direction of improvements in the machinery to enable more ground to be treated per month with the same number of hands. If this can be done, dredging low-grade ground may survive an ugly reverse in the market; if not, many thousands of tons of tin will remain in the ground.

Salt Discovery in Nova Scotia.—In the *Canadian Mining Journal* for January 8, L. Heber Cole gives some information relating to a new discovery of rock salt near Malagash, Cumberland County, Nova Scotia. This is the first discovery of rock salt in the

Maritime Provinces. The only salt-producing district in Canada at present is the Western Ontario district. The Maritime Provinces consume about 50,000 tons of salt in the fishing industry each year, but owing to prohibitive freight rates the Ontario salt cannot be used, so salt has to be procured either from England, Spain, or the West Indies. On the Atlantic sea-board of the United States, as well as in Newfoundland, a considerable tonnage of salt is imported for the curing of fish, etc., as is the case in the Maritime Provinces, and the new deposit should supply these requirements as well as the local demand.

In the autumn and winter of 1916–17, a number of wells were drilled for water by Peter Murray on his farm on the Malagash road, about seven miles north-east of Malagash Station. In each case salt water was encountered, at depth, varying from 70 to 90 ft. A sample of this brine was forwarded by Allan McKenzie to the author, at Mines Branch, Ottawa, who found it to be a saturated brine. In the summer of 1917, A. R. Chambers and George McKay, of New Glasgow, took an interest in the operations, and drilled a series of holes, including a diamond-drill hole, with the hope of proving the presence of a bed of rock salt, and, if successful, to obtain some idea of its extent. The results of the drillings proved unsatisfactory, no cores being obtained. A prospect shaft was commenced in June, 1918. In this shaft rock salt was cut at a depth of 85 ft. from the surface, and when visited by the author on October 10, 1918, it had penetrated to a depth of 17½ ft. in the salt formation. The overlying beds penetrated by the shaft are in a nearly horizontal position. They consist of clays, soft shales, and gypsiferous muds. The underlying saline beds dip to the west of south at an angle of about 25°, and have a strike of 70°. The saline beds, as encountered in the shaft, show, in the upper 12 ft., considerable impurities in the form of mud, but whiter rock salt is now being excavated at the bottom of the shaft. The indications from a drill hole located on the site of the shaft are that the salt beds have a thickness, at this point, of nearly 50 ft. The saline beds are found associated with beds of gypsum mapped by Fletcher as of lower Carboniferous age. These gypsum beds are seen exposed on the shore to the north of the shaft. To the south of the shaft there is a small unmapped outcrop of what appears to be New Glasgow conglomerate. The salt beds are on the south slope of an anticline, and little is so far known as to their lateral extent. To the west, about one mile from the shaft, there is a pronounced fault shown in the shore section, and this may cut off the western extension of the beds. To the east, about the same distance, the occurrence of a marsh, caused by the sea eroding the northerly lying and protecting sandstone barrier, may determine the eastern extension of the deposit. The evidence at hand, however, indicates the presence of a salt formation of considerable extent. On the basis of data obtained from the shaft, from surface indications, and from the drill holes, it is possible that the saline formation, measured at right angles to the dip, may have a thickness of 175 ft. Although the quantities of potash salts (1% KCl) present in the two samples examined from this locality are small, it does not of necessity mean that they are absent in commercial quantities in this area. The drillings and prospecting so far carried out have only in the most superficial way indicated the presence of a large bed at one horizon, and the probability of finding potash salts, interbedded with the sodium chloride at other horizons than the one penetrated by the prospect shaft and drill holes, is quite within the bounds of possibility.

Fluor-Spar in South Africa.—In the *South African Journal of Industries* for December, Dr. Percy A. Wagner has an article on fluor-spar. This is the seventh of a series on the non-metallic minerals of South Africa, many of which we have quoted. As we gave a good deal of information relating to fluor-spar in our issue of May, 1916, we do not here reproduce Dr. Wagner's general account of the distribution and uses of the mineral, and confine our extract to the part dealing with its occurrences in South Africa.

The most important occurrences of fluor-spar hitherto discovered in South Africa are situated to the south-east of Ottoshoop, in the Zeerust district of the Transvaal. Two deposits are actually being worked on a small scale. The former of these, situated on the farm Malmani Oog, No. 101, appears to be of the nature of a large pipe in the dolomite of the Transvaal system. It has been opened up to a depth of 30 ft., and a very large tonnage is said to be available. The spar is colourless, and has been shown by chemical analysis to be of great purity. Practically the whole of the output is handled by a large firm of manufacturing chemists at Boksburg, B. Owen Jones, Ltd., who supply various gold mines on the Wit watersrand and elsewhere in the Transvaal. Small qu antities are also used by the South African Railways. The owner of the deposit is J. G. Gubbins. The other deposit is situated on the adjoining farm Nauuwpoort No. 102. It also yields fluor-spar of great purity, which is used by the Union Steel Corporation at Vereeniging in their open-hearth furnaces. The owner of the deposit is A. R. Foyer.

Fluor-spar is also found in the Zeerust district on the farms Witkop No. 228 and Buffelshoek No. 284. Here it occurs in association with blende, galena, pyrite, and calcite in peculiar pipe or chimney-like deposits in the dolomite series. In another occurrence in this district, which is being opened up by a Johannesburg syndicate, fluor-spar is said to occur in commercial quantities in association with galena.

On the Waterberg tinfields the mineral has a wide distribution in the tin occurrences in the red granite. It has been recorded from the Zaaiplaats, Groenfontein, Groenvlei, and Appingadam mines. It is also found in the Rooiberg and Leeuwpoort tin mines, and according to H. Martin a persistent vein of coloured fluor-spar, ranging in width from 18 in. to 3 ft., was opened up some years ago on the farm Vlakfontein No. 2,235, about four miles north-east of the Leeuwpoort mine.

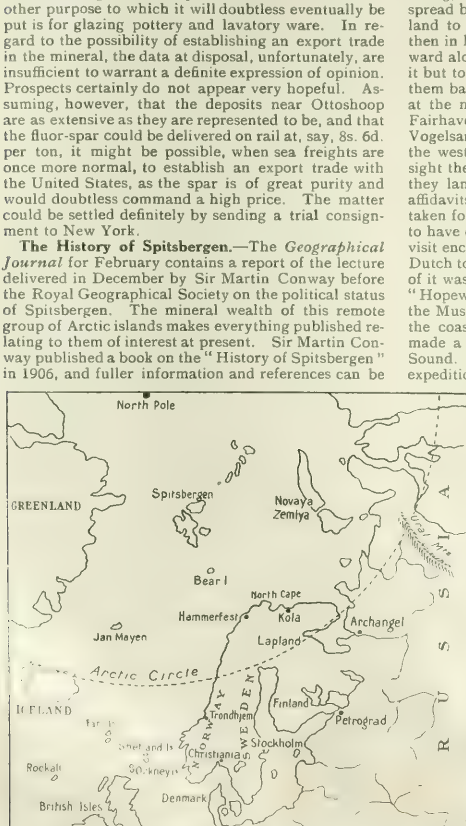
On the Olifants River tinfields it is found in fairly considerable quantities in the Stavoren Mine, and it also occurs in the Mutue Fides mine. The Stavoren fluor-spar varies greatly in colour, ranging from deep bluish-violet to colourless. Several tons of pure lump spar, recovered as a by-product of the tin-mining operations, are available at the mine. Another interesting occurrence of the mineral is on the farm Houtenbeck No. 392, where it is found in pegmatite in association with monazite and molybdenite. The fluor-spar is of deep bluish-violet colour. Fluor-spar of dark violet colour is a common accessory constituent of the elaeolite syenites and allied alkali rocks of the Bushveld complex ; also of the alkali felsites of the Pilandsberg.

In Southern Rhodesia the mineral is occasionally found in the veins and dykes of pegmatite intersecting the rocks of the basement complex. In the Protectorate of South-West Africa fluor-spar has been recorded from the neighbourhood of the farm Stinkdoorn, in the Great Kharas Mountains.

The South African requirements of fluor-spar, amounting to about eight tons per month, have for some time past been derived exclusively from the deposits in the Zeerust district. The principal consumers are the Witwatersrand gold mines and the Union Steel Works at Vereeniging. The selling price of the spar appears to range from £4 per ton for lump to £6. 10s. per ton for the ground product. The demand for the mineral will increase *pari passu* with the expansion of the South African iron and steel industry, as the composition of the principal local iron ores is such as to render the adoption of the basic open-hearth process of steel manufacture imperative. In view of the fact that South African coke is, generally speaking, very high in sulphur, fluor-spar might also with advantage be used by local iron founders. Another purpose to which it will doubtless eventually be put is for glazing pottery and lavatory ware. In regard to the possibility of establishing an export trade in the mineral, the data at disposal, unfortunately, are insufficient to warrant a definite expression of opinion. Prospects certainly do not appear very hopeful. Assuming, however, that the deposits near Ottoshoop are as extensive as they are represented to be, and that the fluor-spar could be delivered on rail at, say, 8s. 6d. per ton, it might be possible, when sea freights are once more normal, to establish an export trade with the United States, as the spar is of great purity and would doubtless command a high price. The matter could be settled definitely by sending a trial consignment to New York.

The History of Spitsbergen.—The *Geographical Journal* for February contains a report of the lecture delivered in December by Sir Martin Conway before the Royal Geographical Society on the political status of Spitsbergen. The mineral wealth of this remote group of Arctic islands makes everything published relating to them of interest at present. Sir Martin Conway published a book on the "History of Spitsbergen" in 1906, and fuller information and references can be obtained therefrom. Another book called "Spitsbergen in Diplomatic History" was written in Norwegian by Arnold Raestad, and it was translated into French by Charles Rabot in 1912.

On June 17, 1596, a Dutch ship, of which Jacob Heemskerke Hendricks was captain and William Barents chief pilot, came in sight of Spitsbergen for the first time on record. The expedition had been sent forth to discover the North-East Passage. It had consisted of two ships, but they had separated. The ship with Barents on board had sailed northward till it met the edge of the ice-pack at a point about due north of the north-west corner of Spitsbergen. They sailed eastward along it some 44 miles and then, the fog lifting, they beheld the north coast of the island wide spread before them, stretching from Hakluyt's Headland to about the mouth of Liefde Bay, they being then in lat. 80° 10′. Next day they sailed back westward along the coast, their effort being not to land on it but to get away from it. The ice, however, drove them back, and late on June 21 they came to anchor at the mouth of the fine harbour afterward named Fairhaven, between the small islands Cloven Cliff and Vogelsang. On the 24th they sailed southward down the west coast, and noting the many pointed hills in sight they named the land Spitsbergen. On the 25th they landed in Magdalena Bay, and according to affidavits made at a later date they appear to have taken formal possession of the land for Holland, and to have deposited among some rocks a record of their visit enclosed in a box. No attempt was made by the Dutch to utilize this discovery in any way, but the fact of it was well known. In 1607, Henry Hudson in the "Hopewell," belonging to an English company called the Muscovy Company, after spending some time on the coast of Greenland, sailed for Spitsbergen and made a landing somewhere near the mouth of Ice Sound. This company used to send forth yearly an expedition to Bear Island halfway between Norway and Spitsbergen to kill walruses, seals, and bears. Their expedition of 1610, under Jonas Poole, was ordered to go on to Spitsbergen and see what could be done there Poole discovered "sea-coales which burnt very well," doubtless the outcrop near the south shore of King's Bay which has become famous in recent times. He returned to England and gave so favourable a report to his employers that they decided to despatch a larger expedition to Spitsbergen next year. In 1611 Poole and Edge were sent forth by the Muscovy Company with six Biscay whalers and the necessary equipment for the whale-fishery, but the expedition was a failure and ended in shipwreck. In 1612, sailing under charter from the Privy Council, they had better luck, for they killed seventeen whales and returned safely home. They did not, however, have the country to themselves, for the Dutch sent up a rival ship, and one came from Biscay and returned home with a full cargo. In 1613 there was great rivalry in the Spitsbergen whale fishery. Beside the Muscovy Company's seven ships there were interlopers from Biscay, Holland, and England. Among the latter came Thomas Marmaduke, of Hull. He landed at Fairhaven and carried off a post with the arms of Holland which Barents had set up. For many years the claims of the English and Dutch to Spitsbergen



Map showing position of Spitsbergen.

caused rivalry. The Danes also put in a claim to ownership, believing Spitsbergen to be, as Barents had supposed, a part of Greenland, which certainly belonged to Norway and so to the King of Denmark. Moreover, the King of Denmark, as King also of Norway, by old tradition claimed to be lord of all the Arctic Ocean. This claim appears to have been generally accepted. The King of Denmark therefore claimed the right to all fisheries in the northern seas. Holland and England had rights of fishery there, but only as the result of treaties with Denmark-Norway, which however the Danes claimed required renewal every seven years. Lengthy discussions on this fishery question were held between the Danes and English down to the end of Elizabeth's reign, and between Danes and Dutch over a series of years; the result being that Norway abandoned an attempt to enforce its rights beyond a seven-mile limit from the coast, and this was afterwards reduced to four miles. As late as 1643 and 1651 Denmark asserted its right to prevent fishing in the territorial waters of Spitsbergen, but the assertion then was an empty protest.

For the last two centuries claims to ownership have lain dormant until recent mineral developments called attention once more to the islands. It is a fact that the only country which at any time for a long series of years consistently claimed and actually occupied any considerable part of Spitsbergen was Great Britain. All the part of the main island south of the Seven Glaciers was recognized as belonging to England throughout the seventeenth century, and that is the area that includes the whole of the coal and mineral district now attracting attention. The north-west corner of the island belonged unquestionably to the Dutch. With so many recent claims put forward by Russia and Germany, this history by Sir Martin Conway is of timely interest.

An Alluvial Gold Mine in Korea.—An article in the *Far Eastern Review* (Shanghai) for December contains an article written by an unnamed American engineer describing an alluvial gold mine near Pyeng Yang, Korea, operated by local people.

In Korea water is proverbially the enemy of the placer miner, as it often is in the Malay Peninsula workings. In the flat valleys the native miners are often baulked by the difficulty of pumping the water from the workings. They have a native pump made of a shallow wooden box with four ropes attached, and operated by two men at the sides. With a rapid swinging motion they snatch a boxful of water from a sump below and toss it into a catch-basin above. In former times, and occasionally even now, large pits were unwatered by this means, the pumps working in steps, one above the other, to raise the water the necessary height, and often with several sets of men on each step working abreast. During the last few years, however, centrifugal pumps driven by steam or oil engines have been employed to fight the water, and several large mines have been thus opened up. One of the largest of these is the mine described by the author. About four hundred men are employed and the ownership and management are entirely native. The pumping plant is at the lower end of the mine, connected with all the workings by a canal. This drains the property and relieves the miners of further trouble on this account, except that when nearly down to bed-rock a few native pumps are used in each pit to raise the water from the bottom up to the level of the drainage canal. Apart from the pumping plant with its small steam engine and centrifugal pump, all the methods and equipment are strictly native. This, of course, means the entire absence of machinery and the minimum even of iron implements, combined with the maximum of human labour. The mining system is simple. Pits about one hundred feet square are taken out. The top twenty feet of dirt is stripped off and thrown on the waste heap, after which the pay, the last few feet above bed-rock, is dug up, carried to a sluice where it is washed with running water, and the residual material from there panned by hand. The pits are started in succession, several being in process of excavation at the same time. This gives the operators a steady revenue, for in one pit or the other pay is always being excavated. It has also the incidental advantage for the visitor that all steps of the operation can be seen working at once.

To a foreigner an amazing feature is the entire absence of shovels, except the giant shovel, a remarkable tool used in digging ditches, operated by five men, one holding the handle and the other four pulling on ropes attached to the blade. In the regular work a small native pick and a shallow basket holding a good shovelful comprise the miner's equipment. With these he attacks the pile of dirt at the face, breaking the lumps with the pick and scraping the dirt into the basket. The contents of this he keeps dumping into a larger back-carrying basket on the back of a man nearby. The basket coolie corresponds to the mine car in America, and although his individual capacity is small, the deficiency is made up in numbers. Along all the working faces are long lines of them, backed up waiting for the gangs of miners to fill their baskets, and continuous streams keep arriving empty and hurrying away with loads.

The sluice, beside which the coolies dump their baskets of pay-dirt, is a channel a few feet wide and fifty feet long cut in the ground, the bottom lined with flat stones and the sides with boards. Water from the pumping plant is used to furnish a sluice head. As the gold is fine and associated with large amounts of black sand and clay, the washing is a difficult matter. The sluice is always the centre of a crowd of men, some with paddles breaking up the lumps and stirring the material as the water carries it along, others with coarsely woven wicker scoops removing the stones and large pebbles, and still others feeding the pay-dirt in at the top and scraping away the tailing. A clean-up is made once a day, the stones in the bottom of the sluice being taken up, and the gold and black sand that has lodged between them removed for a final panning in large wooden bowls.

At first sight a mine of this kind, swarming with men, appears a hopelessly crude and wasteful affair, but a little study reveals a good deal to admire in their methods. Very few of the hundreds of coolies need have any pangs of conscience when they draw their pay. They are given very little chance to shirk. The miners, pumpmen, and a few others are paid by the day at the rate of from 20 to 25 cents gold for ten hours. To see that they earn this, overseers are stationed at the sides of the pits and at other strategic points. It is no use for the miner to wait for these bosses to turn their backs so he can take a few minutes off, because their backs are comfortably resting in easy chairs. With an awning overhead they sit in most un-American fashion with nothing to distract their attention from the work below. The coolies who carry the dirt cannot be supervised quite as closely, but they are paid in a different way. On each trip every man as he comes out of the pit receives a brass check. These are cashed in at the end of the day. A very industrious coolie, under this system, can make as much as 35 cents a day, while if he is lazy he can idle away as much as he wants, at his own expense. Some parts of the work, such as building dykes, digging ditches, etc., are done on contract, each contractor hiring a few coolies whom he has to keep very busy if he wants anything left over for himself. Still another system of payment, and a very curious one, is used for a class of men known as "beggars." They wait around the mine and help when a few extra men are needed for some particularly heavy piece of work. In payment they are presented occasionally with a lump of the paystreak, the value of which is more or less according to whether their luck is with them or not. The washing of this gives them something to do while the work is slack, while the appeal to their gambling instinct induces them to work for less than they would otherwise demand.

All the men in the mine rest half-an-hour in the middle of the morning and another half-hour in the afternoon, an arrangement that seems strangely like some of the methods the modern study of efficiency has introduced into American plants. It is admitted that a Korean can get more out of his countrymen than any foreigner can, perhaps because they have in the past been giving some of the attention to this problem that the foreigner has to the development of machinery. If we wonder how a mine run on such crude methods can be made to pay, probably the Korean manager would wonder still more how one of our mines, full of expensive machinery, can meet the interest and depreciation charges and the expense of repairs and have anything left over. At any rate this mine is being run at a profit. Some large native enterprises have been failures, but this was usually due more to the fact that the power pump could not handle enough water than to any shortcomings on their part as miners.

SHORT NOTICES

Gas Detectors.—In the *Colliery Guardian* for February 14 and 21, T. J. Thomas describes a miner's electric lamp which will detect ½% of methane in the air, and will become automatically extinguished when the proportion of methane becomes dangerous. In addition, the lamp has the notable property that in the event of the bulb being broken, the lamp is extinguished with certainty before any methane can approach the filament.

Diamond-Drilling.—In the *Engineering and Mining Journal* for February 15, R. H. Poston describes the method of cementing diamond-drill holes employed in the lead district of south-east Missouri.

Draper's Coal Washer.—The *Engineer* for February 21 gives an illustrated article of Draper's coal washer, a paper on which was recently read before the South Wales Institute of Engineers.

Mine Cars.—The *Engineering and Mining Journal* for February 1 publishes a paper by Professor R. M. Raymond on the standardization of mine cars

Circular v. Rectangular Shafts.—At the January meeting of the South African Institution of Engineers the question of the relative advantages of circular and rectangular shafts was debated. H. Stuart Martin, W. L. White, and C. E. Knecht read papers on the subject.

Concentrating Plant.—The December number of the *Queensland Government Mining Journal* contains a description of a new concentrator erected at the Cannindah copper mine, at Many Peaks.

Ball-Mills.—The February *Bulletin* of the American Institute of Mining Engineers contains a paper by E. W. Davis recounting experiments on ball-mills in connection with the problem of concentrating silicious magnetite ores.

Copper, Lead, and Zinc.—In the annual review number of the *Engineering and Mining Journal*, January 11, A. L. Walker writes on progress in the metallurgy of copper, H. O. Hofman on lead, and W. R. Ingalls on zinc.

Puddling.—On February 8, Cecil H. Desch, professor of metallurgy in the Royal Technical College, Glasgow, read a paper before the Staffordshire Iron and Steel Institute on the history of the puddling process.

Recovering Blast-Furnace Dust.—The *Iron and Coal Trades Review* for February 14 gives some particulars of the application of the Dorr thickener to the recovery of solids from the water used in scrubbing blast-furnace gas.

Aluminium.—The *Journal of the Franklin Institute* for January contains a lengthy paper on the metallography of aluminium by Robert J. Anderson. It contains a very full bibliography.

Quicksilver.—*Chemical and Metallurgical Engineering* for January 15 contains a translation of an article by R. Sterner-Rainer on minor occurrences of quicksilver ores in Europe.

Electrostatic Precipitation.— In *Chemical and Metallurgical Engineering* for January 15, E. E. Thum reviews the present application of the Cottrell electrostatic method of settling dust and fume and many recent improvements in detail.

Electric Smelting.—Dr. Alfred Stansfield has issued his report on electric smelting of British Columbia iron ores made for the Provincial Government. An abstract of the report is given in the *Canadian Mining Journal* for January 29.

Zinc Metallurgy.—In the *Engineering and Mining Journal* for February 1, W. R. Ingalls gives an outline of zinc-smelting capacity in countries other than the United States.

Copper Metallurgy.—In the February *Bulletin* of the American Institute of Mining Engineers, S. Skowronski and K. W. McComas write on the volatilization of cuprous chloride on melting copper containing chlorine.

Copper Leaching.—In the February *Bulletin* of the American Institute of Mining Engineers, H. A. Tobelmann and J. A. Potter give the results of the first year's working of the leaching plant of the New Cornelia Copper Company, Ajo, Arizona.

Spitsbergen.—The *Mining and Scientific Press* for January 4 contains a communication relating to the activities of the American company, the Arctic Coal Co., in Spitsbergen.

Cloncurry Copper. — In *Chemical Engineering and Mining Review* for November and December, S. Harris, manager of the Mount Cuthbert mines, discusses the resources of the Cloncurry copper district, from the point of view of the development of ores of lower grade.

Wolfram and Molybdenite.— The *Queensland Government Mining Journal* for October contains an article by Dr. H. I. Jensen describing wolfram and molybdenite occurrences in the Stanthorpe-Ballandean district.

Arsenic.—The *Queensland Government Mining Journal* for October and November contains an article by Dr. H. I. Jensen on arsenic and its occurrences in South Queensland.

Bawdwin Mines.—In the *Engineering and Mining Journal* for February 8, A. B. Parsons describes the mines and plant of the Burma Corporation.

Potash.—In *Chemical and Metallurgical Engineering* for January 15, H. P. Bassett discusses methods of separating potash salts from mixed liquors such as those obtained from natural deposits of salts.

RECENT PATENTS PUBLISHED.

6,344 of 1917 (122,204), Bore-hole Surveying.—DR. HENRY BRIGGS, Heriot-Watt College, Edinburgh. The invention consists of a clinometer or transmitting apparatus which is supported in the bore-hole, and an indicating apparatus which is situated at any convenient place usually near the mouth of the hole. The transmitter and indicator or receiver are linked by a multistrand electric cable. The apparatus is in connection with any suitable electric supply, either direct or alternating current. Alternating current is, however, preferable, and the supply may conveniently be drawn from an induction coil worked by one or more cells. Fig. 1 is a vertical section of the transmitting apparatus in the position it would occupy in a strictly vertical hole. This apparatus consists of a plummet *p*, suspended from a wire *a*. The bottom of the plummet is provided with a projecting point *n*, which dips into a high-resistance liquid in the dish *c*. The dish is made of a suitable non-conducting material, such as vulcanite, and is filled to the level of the line *l* with the liquid. A solution of sodium sulphate forms a suitable high-resistance liquid. The point of the plummet, which hangs quite freely, takes up a position in the dish according to the deflection of the bore-hole from the vertical. The design illustrated in Fig. 1 is of an instrument of great accuracy and small angular range. By shortening the wire *a*, a larger range can be obtained at the expense of reduced precision. Placed against the sides of the dish *c*, and dipping into the liquid, are four electrodes of metallic foil. In Fig. 3, which is a plan of the dish *c*, these electrodes are indicated by the letters N, S, E, and W. The electrodes are respectively connected, through the medium of plug-and-socket joints (s^1 and s^3, Fig. 1) and the wires W^1, W^2, W^3, and W^4 to the terminals t^1, t^2, t^3, and t^4. These terminals are supported upon the insulating disc *d*. Fig. 2 is a plan of the disc *d*, and shows the position of the terminals named and also that of a fifth terminal t^5, which is connected to the plumb-wire *a*. A five-strand cable, passing through the gland *r*, is connected to the said five terminals. The instrument is lowered in the hole by means of a column of rods, and, if the direction or bearing of the deviation is to be ascertained as well as the amount, the instrument is adjusted by aid of the rods, so that the electrode *n* is to the north side of the dish; the electrodes N, S, E, and W will then be respectively directed towards the north, south, east, and west points of the compass. At the receiving station there is a second dish c^1 (Fig. 4) containing some of the same electrolyte as *c* contains and similarly fitted with four electrodes N^1, S^1, E^1, and W^1 (Fig. 4). The lower part of the figure represents the transmitter and the upper part the receiver. The connections are, in effect, those of the Wheatstone bridge applied twice, the liquid at the receiving station serving the function of the stretched wire of the simplest type of Wheatstone bridge. Telephone receivers T^1 and T^2 take the place of the galvanometers of Wheatstone, the alternating supply being introduced by the lead *q*. Ordinary galvanometers are used when the supply is direct current. A metal needle n^1, connected by a flexible wire to one of the leads *q*, is made to dip into the liquid in c^1, and is moved by hand until a minimum of sound is heard in both telephone receivers. The needle n^1 then occupies a position in the dish c^1, exactly corresponding to the position of the plummet point *n*, in the dish *c*. Thus the amount and direction of the deflection of the bore-hole is indicated. The readings may conveniently be taken upon a graduated circle engraved upon, or attached to, the bottom of the dish c^1. In this manner readings may be rapidly taken of the course of the bore-hole at any number of points along its length without having to withdraw the transmitting clinometer from the hole between the readings.

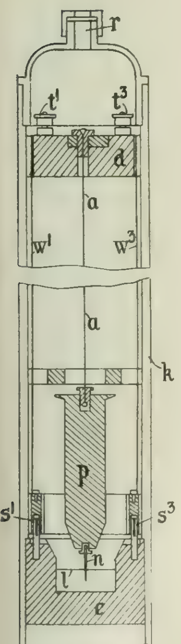


FIG. 1.

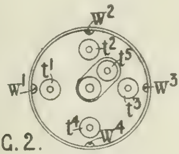


FIG. 2.

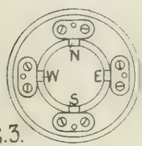


FIG. 3.

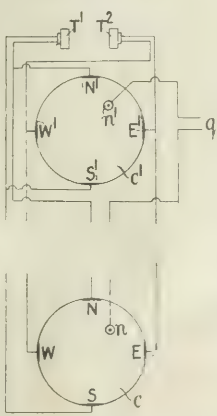


FIG. 4.

BRIGGS'S BORE-HOLE SURVEYING INSTRUMENT.

17,413 of 1917 (112,929). STANDARD OIL CO., M. BARNETT, and L. BURGESS, New York. Electric manufacture of aluminium carbide from alumina and carbon, more particularly petroleum residue containing alumina and carbon.

1,149 of 1918 (122,048). T. TWYNAM, Middlesbrough. Extracting potash from blast-furnace slag, by mixing with the latter when still molten a certain amount of common salt which has the effect of releasing potash salts as fume.

1,337 of 1918 (122,474). BRITISH OXYGEN CO., LD., S. W. BRAY, and I. H. BALFOUR, London. Method of treating spathic iron ore in order to make it porous and present a greater amount of surface so that it shall be more efficient in the manufacture of hydrogen by the water-gas-steam-iron process.

1,390 and 1,391 of 1918 (122,051 and 122,264). J. B. EKELY and W. B. STODDARD, Boulder, Colorado. Method of producing sodium tungstate from wolfram ores by fusing with carbonate of soda and common salt, adding silica and a chlorate if necessary, and a method of purifying the solution obtained; the patent also covers similar treatment of molybdenum, vanadium, and uranium ores.

1,603 of 1918 (122,688). J. ARMSTRONG, London. A zinc distilling furnace, arranged vertically, acting continuously, without allowing access of air.

2,078 of 1918 (113,278). NÖRSKE AKTIESELSKAB FOR ELEKTROKEMISK INDUSTRI, Christiania, Norway. Extracting alumina from labradorite-anorthite rocks, by attack with chlorine, hydrochloric acid, or nitrogen oxides; these rocks, if containing iron compounds, contain such as are not readily attacked.

2,083 and 12,160 of 1918 (122,709). C. M. CONDER, London. Machine for excavating superphosphates from the plant after their formation.

2,247 of 1918 (122,712). O. F. S. CARLSON, Ljungaverk, Sweden. In furnaces for roasting or drying consisting of a number of shelves or floors, improved method of stirring, having for its object the more regular advance of the material.

3,057 of 1918 (122,523). A. R. LINDBLAD, Stockholm. Improved electric furnace for producing metallic nitrides.

3,624 of 1918 (115,020). TITAN CO., Christiania, Norway. Separating titanium from iron by treating the titaniferous iron ore in an atmosphere of nitrogen, forming titanium nitride, which can be converted into a titanic oxide pigment and an ammonia compound.

3,842 of 1918 (122,534). HUNTINGTON, HEBERLEIN & CO., and H. C. BINGHAM, London. Improved construction of electrostatic apparatus for precipitating dust from gases.

4,545 of 1918 (115,023). J. GAYLEY, New York. Sintering machine intended chiefly for agglomerating magnetite concentrate on a large scale.

4,633 of 1918 (114,309). INDUSTRIEN MIJNBOUW TITAN, The Hague. Method of smelting titaniferous iron ores, involving a combined use of the blast furnace and electric furnace.

6,193 of 1918 (122,335). UNITED STATES NICKEL CO., New York. In separating nickel and copper, giving the matte a partial roast to reduce the sulphur content to 8%, then reducing the oxides so as to produce a low-sulphur matte, subjecting this to dilute acid to dissolve the nickel and nickel sulphide, leaving the copper behind.

6,525 of 1918 (115,425). E. RIDONI and SOCIETA TALCO E GRAFITI VAL CHISONE, Turin. Improvements in the plant and process for making hydrofluoric acid by the reaction of sulphuric acid and fluor-spar.

7,025 of 1918 (122,566). C. W. and C. CROCKER, Irvine, Scotland. In zinc distilling providing the nozzles or prolongs with interior baffles and exterior coolers so as to recover as much of the escaping zinc vapour as zinc dust as possible.

9,233 of 1918 (122,119). EDGAR ZINC CO., St. Louis, U.S.A. Machine for charging zinc retorts.

10,283 of 1918 (122,779). G. A. HERDMAN, Redcar. Method of producing slag wool.

21,520 of 1918 (122,618). SIR H. ROGERS, M. L. LANCASTER, C. M. WALTER, and J. JACKSON, Birmingham. In recovering tin from scrap using an electrolyte containing 1% of tin chloride in a 7 to 10% solution of caustic soda or potash.

NEW BOOKS

The Cyanide Process: Its Control and Operation. By A. W. Fahrenwald. Price 9s. 6d. net. New York: John Wiley and Sons; London: Chapman and Hall.

The function of this book is to be a guide both for the investigation of ores in the laboratory and for the control of operations in the mill. The book is divided into sixteen chapters and there is an index. Chapter 1 deals with the properties of gold and silver and consists of data from standard authorities. Chapter 2, on the nature and properties of cyanide, gives the author's ideas on the chemistry of cyanide, with which a professional chemist is not likely to agree. Chapter 3, on the suitability of an ore for the cyanide process, covers the ground fairly well, but contains some curious statements, of which the following may be cited: "Most gold ores containing antimony are impossible to treat, owing to their hardness." Chapter 4, on the dissolution of gold and silver in cyanide solution, Chapter 5, losses of cyanide, and Chapter 6, alkalinity and lime, give the current views on these subjects. Chapters 7 and 8, on the assaying and testing of ores, are quite good. In describing the titration for cyanide strength, although sodium cyanide is the salt now universally used, the author only gives data for, and states results in terms of, potassium cyanide. Chapter 9 describes the use of lead salts in connection with extraction and precipitation, and Chapter 10 contains a short description of the various methods of decantation and filtration. Chapter 11 describes the methods of precipitating gold and silver from cyanide solutions by means of zinc and aluminium in various forms, by charcoal, and by electrolysis. The precipitation of silver by sodium sulphide is also described. The various methods of treatment of the product and refining of the bullion are described in Chapter 12. The rate of settlement and control of slimes are described in Chapter 13, and Chapter 14 discusses the cyanide treatment of flotation concentrates. First aid in cyanide poisoning occupies Chapter 15, and Chapter 16 comprises the usual collection of useful data. The book should be a practical help to the student and beginner, but it would be greatly improved if the author expressed himself in clearer and better English. A number of printer's errors occur in the text. The book is well printed and bound, and is of convenient dimensions. BERTRAM HUNT.

A Manual of Geometrical Crystallography. By G. Montagu Butler. Pocket size, cloth, illustrated. Price 7s. net. New York: John Wiley & Sons; London: Chapman & Hall.

This handy little book contains many excellent features, but it carries novelty and originality to an extreme that seriously militates against its usefulness, without making it more readable than the more conventional textbooks. The author employs well recognized terms such as "symmetry axis" and "parameter" in entirely new senses, and introduces a distinction between principal and secondary symmetry planes upon which he bases the whole of his treatment of the subject of symmetry. His summary of the different systems and the crystal forms is fairly good, and his lists of the synonyms of the latter should be useful. Instead of the Miller indices, with which students in this country are now familiar, he employs the Weiss system, which is certainly preferable to that of Naumann, which still lingers in some quarters in the United States. His account of twin crystals is simple and intelligible, but it is not correct to say that a twinning plane must be parallel to a possible crystal face.

The Journal of the Institute of Metals. Vol. XX, Cloth, octavo, 382 pages and 19 plates. Price 21s. net. Edited by G. Shaw Scott, M.Sc. London: The Institute of Metals, 36, Victoria Street, S.W.1.

Though essentially a record of a series of meetings held in war time, the twentieth volume of the Journal of the Institute of Metals makes a post-war appearance and will be found, appropriately enough, to include valuable metallurgical information relating both to war and to peace. A special feature of the new volume is the illustrated May Lecture, on "The Formation of Diamond," which was delivered before the Institute by the famous inventor of the steam-turbine, the Hon. Sir Charles Parsons, and of which the publication has been awaited by those interested in the various branches of applied science that Sir Charles called to his aid in carrying out his classic experiment on diamond formation. We gave an outline of the lecture in our June issue. Thirteen other communications, covering a wide range of subjects of metallurgical interest, are included in the Journal. One of these—that on "The Use of Oil Fuel in the Foundry"—was written at the Front by a member of the Institute of Metals. Two others, dealing with grain growth in metals, and the annealing of aluminium sheet respectively, are contributed by American metallurgists, the remainder being devoted largely to copper, brass, bronze, and laboratory problems, the work of well-known British men of science. The volume concludes with some hundreds of concise summaries of the world's metallurgical publications during the past half-year, and a very complete index.

Offical Year-book of the Scientific and Learned Societies of Great Britain and Ireland. Cloth, octavo, 350 pages. Price 9s. net. London: Charles Griffin & Co., Ltd. This is the 35th annual issue of an invaluable book of record. It gives particulars of the scope and object of the various societies, and accounts of the papers read during the session 1917-18.

Asbestos in the Union of South Africa. By A. L. Hall. Price 5s. This is Memoir No. 12 of the Geological Survey of the Union of South Africa. Asbestos is one of South Africa's important non-metallic minerals. We gave an outline of the industry when quoting Dr. P. A. Wagner's paper on the subject in our issue of March, 1918.

The Occurrence, Chemistry, Metallurgy, and Uses of Tungsten. By J. J. Runner and M. L. Hartmann. This is bulletin No. 12 of the South Dakota School of Mines, and it has special reference to the deposits in the Black Hills. It contains a great deal of useful general information, and has an elaborate bibliography.

COMPANY REPORTS

Tincroft Mines.—This company operates the Tincroft tin-arsenic-wolfram mine situated between Camborne and Redruth. James Wickett is chairman and W. Thomas is manager. The report for the half-year ended December 31 shows that 25,826 tons of ore was raised, and that 175 tons of tin concentrate was extracted, being a yield of 15·2 lb. per ton. The amount realized by its sale was £34,956. In addition, £20,051 was received from the sale of arsenic, and £2,846 from the sale of wolfram. The total receipts were £58,583, and the working cost was £56,281. After paying £1,570 royalty, a profit of £731 remained. During the previous half-year the profit was £14,954, but that was an exceptional profit. During the half-year under review the total output of tin and the yield per ton were the lowest on record. As regards development, the bottom of the mine is said to be "looking favourable, quite satisfactory values having been met with in sinking below the 208 fm. level."

Mount Morgan Gold.—The cabled report of this company operating the celebrated gold-copper mine near Rockhampton, Queensland, for the half-year ended November 30 last was briefly quoted in our January issue. Since then the full report has come to hand by mail. During the half-year 186,032 tons of ore was raised, averaging 2·33% copper and 5·7 dwt. gold per ton. Of this ore, 67,311 tons came from outside the boundary of the proved ore reserve. About one third of the ore mined went direct to the smelter and the remainder to the concentrators. The amount treated in the concentrators was 115,466 tons averaging 2·11% copper and 5·11 dwt. gold. The following concentrates were produced: jig concentrate, 9,755 tons, averaging 2·4% copper and 4 dwt. gold; table concentrate, 25,561 tons, averaging 4·31% copper and 10·11 dwt. gold; flotation concentrate, 6,005 tons, averaging 15·04% copper and 23·63 dwt. gold. At the smelter there were treated 68,237 tons of ore, 10,003 tons of jig concentrate, and 26,320 tons of sintered table and flotation concentrate. The blister copper produced contained 3,850 tons of copper and 42,942 oz. of gold. The revenue for the period was £548,485, and the profit £86,485, out of which £50,000 has been paid as dividend, being at the rate of 1s. per £1 share. The ore reserve is estimated at 3,706,964 tons averaging 2·58% copper and 6·15 dwt. gold.

Fremantle Trading.—This company was formed, as the Western Australian Smelting Co., in 1897, to erect a smelter and work lead mines in the Northampton district of West Australia. An article on these mines appears elsewhere in this issue. E. Protheroe Jones is chairman, and W. G. Sutherland is manager. The company is associated with the Golden Horse-Shoe Estates. The report for the year ended July 31 shows that 6,033 tons of lead ore and concentrate from the company's mines and 1,700 tons of purchased material was smelted, for a production of 4,831 tons of pig lead. The net profit was £5,601, and £5,610 was distributed as dividend, being at the rate of 10%. The development at the Baddera mine has been disappointing lately. At the Narra Tarra and Wheal Ellen the amount of development necessary to maintain the output is extensive, as the lodes are of irregular content and size.

Deebook Dredging.—This company was formed in Victoria in 1913 to acquire alluvial tin ground in Bangnon valley, Renong, Siam. The first dredge started in 1914 and a second in 1915. The first dredge was afterwards put to work on the Ronpibon Extended property. E. T. Miles, the pioneer at Tongkah, is the leading spirit, together with A. W. Palfreyman. The report for the year ended May 31, 1918, shows that No. 2 dredge treated 682,617 cu. yd. for a yield of 235 tons, equal to 12¼ oz. per yard. This sold for £33,701, and the net profit was £16,958. No. 1 dredge started at Ronpibon Extended in August, 1917, and during the period to May 31, 1918, treated 424,249 cu. yd. for a yield of 164 tons of tin concentrate, selling for £27,273. The ground treated was unusually clayey, but the dredge is now in free-working gravel. The Deebook company received £1,500 as dividend on the Ronpibon Extended operations. The Deebook company paid £5,000 dividend in April, and similar amounts in July and October, making the distribution £15,000 or 15%.

Mawchi Mines.—This company was formed in 1911 as the Mawchi Tin and Wolfram Mines, Ltd., to operate tin and wolfram lode mines in the Southern Shan States, Burma. Control changed hands in 1914, and the name was changed. The report for the year ended June 30, 1918, shows that 24,922 tons of ore was milled for a yield of 677 tons of mixed concentrate. After allowance for depreciation and debenture interest, the net profit was £33,689, out of which £33,158 less tax has been distributed as dividend, being at the rate of 15%. Operations were impeded by unusually wet weather, which caused landslides. Developments have added to the reserve, which on June 30 stood at 83.047 tons averaging 3·95% mixed cassiterite and wolfram, estimated by panning assay. The ore treated at the mill was poorer, as, owing to labour shortage, some ore had to be taken from the dump.

Messina (Transvaal) Development.—This company was formed in 1905 by A. M. Grenfell to acquire a copper property in the northern Transvaal. Four years ago H. C. Hoover became chairman and he appointed a new manager. On Mr. Hoover's return to America, C. F. H. Leslie succeeded him as chairman. Dividends were not paid until 1917. The report for the year ended June 30, 1918, shows that 96,719 tons of ore was raised from the Messina stopes averaging 3·5% copper, from the Messina development 18,164 tons averaging 1·55%, and from the Vogelzang mine 5,891 tons averaging 8·6%, while 125 tons averaging 10% was purchased and taken from dumps. The ore was hand-picked and concentrated. The picked ore for shipping was 388 tons averaging 61·9% ore and the shipping concentrate was 3,887 tons averaging 49·9%. The concentrate to be smelted on the spot was 5,826 tons averaging 24·5%. At the smelter, 6,075 tons was treated for a yield of 2,222 tons of matte averaging 61% copper. Owing to the shipping restrictions it was not possible to send ore and matte to England after February 21, 1918, or ore to the United States after June 20. It was possible, however, to sell some ore and matte to Japan. The accounts for the year show a profit of £25,174, but as £13,112 had to be provided for debenture interest and £35,000 for debenture redemption, the actual result was an adverse balance. The proved ore reserve at June 30 was 67,221 tons averaging 4·79%, the probable ore 88,956 tons averaging 3·48%, and the possible ore 141,626 tons averaging 2·8%. The rich ore in the Messina mine is exhausted, and the ore now developed averages about 3%. At the Vogelzang mine the developments are fairly good and there is reason to expect the ore to continue in depth.

Falcon Mines.—This company was formed in 1910 by the Gold Fields Rhodesian Development Co. to work a gold-copper deposit 60 miles east of Gwelo, Rhodesia. The first dividend was paid a year ago. Since then difficulties of shipment of blister copper for refining and realization, together with increases in costs, have greatly reduced the profit and have made it necessary to borrow additional funds. The report for the year ended June 30, 1918, shows that 170,074 tons of sulphide ore was raised and smelted, yielding blister estimated to contain 3,523 tons of copper, 37,700 oz. of gold, and 80,528 oz. of silver. Only about half of the blister copper arrived in New York during the year under review, and that produced from January to June, 1918, did not reach New York before December. In making up the accounts, the unsold copper is taken at £65 per ton. The credit side of the profit and loss account shows items totalling £494,422, and the working profit was £75,309. No less than £50,733 has to be held for excess profits duty, while £30,000 was required for redemption of debentures. Under these financial conditions it has proved necessary to borrow money, and at the present time this liability amounts to £106,000. The position has been rendered worse by the influenza epidemic and the consequent temporary closing of the mine for several weeks in the latter part of 1918. Developments during the year under review did not entirely maintain the reserve, which on September 30, 1918, was estimated at 755,000 tons averaging 2·31% of copper and 5·4 dwt. of gold per ton. No further ore has been discovered on the 10th level, and the ore so far found on the 11th level is not up to the average grade of the reserve. Winzes are being sunk below the 11th level.

Arizona Copper.—This company has its headquarters in Edinburgh, and has worked copper mines at Clifton, Arizona, since 1884. The report for the year ended September 30 last shows that 1,095,568 tons of ore was raised, of which 593,430 tons came from the Humboldt, 164,096 tons from the Clay, 118,829 tons from the Coronado, and the remainder from eight other mines and from certain leases. Of the total, 41,357 tons averaging 6·38% copper was smelting ore, and 1,054,211 tons concentrating ore averaging 2·338% copper. The smelters treated 216,336 tons for a yield of 20,221 short tons of copper, of which 6,590 tons was sold as bessemer and 13,631 tons as electrolytic. The working profit was £805,129, out of which £269,717 was paid as United States taxes. After the payment of administration expenses, debenture interest, etc., the profit was £428,898, of which £130,000 has been placed to reserve for capital outlay and contingent liabilities. The preference dividend absorbed £24,531, and £227,984 has been paid on the ordinary shares, being at the rate of 60% free of income tax. During the first six weeks of the year under review the mine and plant were idle owing to a strike. Since the end of the year the cessation of hostilities has caused a drop in the demand for copper, and at the end of January, 1919, the accumulated stock of unsold copper was about 8,000 tons. The directors have decided to curtail the output to a one-furnace basis, which will mean 1,000 to 1,200 tons per month.

Mexico Mines of El Oro.—This company was formed in 1904 by the Exploration Co. to acquire a gold mine in the El Oro district, Mexico. In 1910 the control passed to the French shareholders, and the head office is now in Paris. C. R. Pinder is the consulting engineer, and Fergus L. Allan is manager. The report for the year ended June 30, 1918, shows that 109,792 tons of ore was raised from the Mexico mine and 7,360 tons from the Nolan. The ore treated at the mill was 121,793 tons, averaging $14·92 in gold and 8·98 oz. silver. The yield in bullion and concentrate was $1,631,373 gold and 945,320 oz. silver. The profit for the year was £264,606, bringing the balance in hand to £378,965. The dividends absorbed £199,500, being at the rate of 95%. Out of the accumulated profits, £100,000 was devoted to exploration and development in connection with other properties. For this purpose, as recorded a year ago, a subsidiary company has been formed in Mexico, to be financed by the profits of the Mexico Mines of El Oro. Developments at the Mexico and Nolan mines continue to expose ore, though it is well known that the chances of extending the reserves in any important degree are not great. The reserve stands at 416,200 tons averaging $11·72 in gold and 8·34 oz. in silver, as compared with 457,100 tons averaging $11·89 in gold and 8 oz. in silver the year before.

MESSINA (TRANSVAAL) DEVELOPMENT CO., LTD.

Directors: C. F. H. Leslie (*Chairman*), J. A. Agnew, R. J. Frecheville, Lt.-Col. J. P. Grenfell. *General Manager:* A. B. Emery. *Secretary:* A. A. Kelsey. *Office:* 1, London Wall Buildings, London, E.C.2. *Formed* 1905. *Capital issued:* £181,788 10s. in shares of 5s. each; debentures £208,964.

Business: Works copper deposits in the Northern Transvaal.

The annual ordinary general meeting of the Messina (Transvaal) Development Company, Ltd., was held on February 20, at Salisbury House, London, E.C., Mr. C. F. H. Leslie (Chairman of the company) presiding.

The Secretary (Mr. A. A. Kelsey, F.C.I.S.) having read the notice convening the meeting and the report of the auditors,

The Chairman said: With your permission we will take the report as read, and I propose to review the position of the company, and, where it is necessary, to amplify the directors' report, and I will then, as I have done in previous years, bring before you the position of the company up to date. I first ask your attention to the profit and loss account, which shows a debit balance of £22,900. This balance is arrived at after deductions of £20,000 for depreciation, £35,000 for repayment of debentures, and £36,500, our liability under the railway guarantee; so that, while the profit and loss account shows a loss, the company has, in fact, during the year reduced its liability to debenture holders by some £36,000 and increased the amount of its liquid resources. It would also appear, seeing that the company will average its profits and losses for the purpose of determining its liability for excess profits tax over the whole period of that tax, that some considerable portion, if not the whole, of this debit balance will eventually be returned to the company when the amount of the tax for which the company is responsible is determined. With regard to the settlement of this question, which is still outstanding, we are in much the same position as last year, and no decision has yet been arrived at. We are acting under expert advice in this matter, and are awaiting certain decisions, both of the Special Commissioners and the Court of Referees, which will have a definite bearing on our case; and we are also in the course of determining whether the profitable life of our mine is ended, or whether new discoveries will prolong that life, a factor which may have an important bearing on this question.

You will notice in the profit and loss account a figure of £36,500 under the heading of "Railroad Guarantee," and some of you may have noticed, on page 20 of the report, an allusion to this matter by our general manager; and I think it will interest you if I go into this subject in somewhat greater detail. When the South African Government originally agreed to bring the railway up to Messina, the company guaranteed the South African Government against its loss in working this particular branch for each year over a period of ten years. Such annual guarantee was not to exceed 4½% on the cost of construction, and it was estimated at the time by the South African Railway Commissioners that the company's loss in respect of the guarantee was not likely to exceed £11,000. This estimate, unfortunately, has proved too optimistic, with the result that the company has become liable for large annual amounts to the South African Government, for amounts, in fact, which, under present circumstances, the company is unable to bear. I may here say that our general policy at Messina has been, more especially during the last few years, to work with the Government in building up the district and in making the Northern Transvaal a fit place in which to live. We have made a point of furthering the interests not only of the company's employees but also of the residents of the whole community, and we have taken an active part in health and educational matters, and, in other ways, in improving the living conditions of the public at large. We are glad to be able to say that the public have appreciated our efforts, and have made known their appreciation; and the South African Government has now recognized the fact that the Messina company is a real asset to the region north of Pietersburg, that it has done and is doing valuable pioneer work in opening up to civilization this semi-tropical and hitherto uninhabited region, and that a genuine and serious loss to this part of South Africa, both direct and consequential, would occur if the Messina company should cease its operations.

During the past financial year several Government officials, including members of the Cabinet, have at various times visited the mine and become acquainted at first hand with the company's industry. Hence we were in a better position to approach the Government, when the need arose for obtaining prompt relief last spring, than ever before. This need arose from the fact that shipments of our products to England were prohibited, and shipments to the United States, due to the high freight rates and higher cost of treatment, were not netting enough to pay our working expenses plus the loss of £36,500 per annum on the railway guarantee. Under these circumstances we therefore petitioned the Government to relieve us entirely from this burden, and pointed out that, failing such relief, we should have no other resource than to shut down the property. After several conferences the Government representatives finally agreed, subject to approval by Parliament, to accept, until August 3, 1925, as full payment for the annual railroad loss, whatever it might be, the Messina company's excess of revenue over working expenses, if any, up to the amount of the loss. Any short-falls in such annual payments will, however, be taken into consideration when the new agreement expires in 1925. At this date, or at an earlier date, should we be compelled by circumstances to shut down the mine, the old agreement revives and is extended by a length of time determined by the sum of the shortfalls. Hence it will be seen that the contingent liability still exists as heretofore, but the immediate payments of railroad losses are postponed for some seven years, unless we make sufficient money to meet them before that date. In calculating working costs for the purposes of this agreement we are allowed to include depreciation, debenture interest, taxes, and the amounts actually spent on development and shaft-sinking. All of these important items of expense, particularly development and shaft-sinking, will therefore be met before any payment will be required on account of the railroad losses. We hope before the old railroad agreement revives in 1925 that either the railroad will have ceased to make a loss or the mine will be better able to earn profits than at present, and I am sure you will agree with me that the concession granted to us by the Government affords us, at least for the next seven years, a very real relief. Put into fewer words, the effect of this agreement is that the annual payment to the South African Government on account of the losses incurred in operating the Messina extension will until the year 1925 be suspended in those years when the Messina company's revenue does not meet its working expenses. The new agreement has not yet been approved by the South African Parliament, but we have every reason to believe that such approval will be obtained during the coming session. Referring again to the balance sheet, I call attention to the fact that since the date of the report the liquidation of the securities account has proceeded; that the amount at which these securities stood in the books as at June 30 last has been realized, and that the company still holds securities which may eventually realize a further sum of from £7,000 to £10,000.

With regard to the operations at the mine, I do not think I can amplify in any way Mr. Emery's report, which deals with the position up to June 30 last. Since that date we have received the usual information from the mine at somewhat irregular intervals, and this has been circulated to the shareholders. Concurrently, however, with the period covered by this report, many difficulties occurred, due to the conditions created by the war, in shipping and selling our product. I propose, therefore, to refer to some matters which will explain the policy of the directors during this period, so that you can judge what the position is at this time as accurately as can your directors. You will note first of all that no shaft-sinking at Messina was proceeded with during the year. The reason for suspension in the early part of the financial year was that there was ample lateral development work to proceed with down to the present depth, and we were desirous too of finding out what the chances of success were at No. 15 level before further sinking. Shaft-sinking, too, on account of varying supplies of labour, has had to be fitted in with our requirements in this respect for other important work.

In the early part of the period under review we experienced some difficulty in securing shipping space for our concentrates and matte. This was temporarily overcome, and we were able to ship our products spasmodically, but at the end of 1917 the difficulties in this respect increased until we were faced with the impossibility of shipping any of this material to the United Kingdom. With no knowledge of what market might be found for concentrates or matte in either the United States or Japan, nor whether shipment of such could be relied on if market could be found, your directors were placed in a difficult and anxious position. We had considerable reserves in the mine of ore that might be expected to yield a good profit if the mill and smelter products could be sold and shipped, and we had further the strong view that, before anything should be allowed to happen that would cause us to close down the mine for an indefinite period, there were certain points of development that it was absolutely essential to prosecute. After the fullest possible consideration, and after consultation by cable with your general manager, it was decided to confine development work to the points mentioned, and to which I shall presently refer, and to push these to the uttermost; to continue milling and matte production, and arrange to store the products for, if necessary, a maximum period of three months. In the meantime every possible inquiry was made regarding markets elsewhere and shipment thereto, with the satisfactory result that we were able to dispose of large shipments in the United States and, subsequently, in Japan. The net result of this was that we were able to keep both mining and treatment operations continuous and on terms, so far as shipping and selling was concerned, that compared not unfavourably with prices realized just previously in the United Kingdom.

The development programme consisted in the pushing on of development on the 14th and 16th levels in the Messina mine and in sinking the Vogelzang shaft to a depth sufficient to permit of the ore shoots in that section being opened for an additional two levels below the 250 ft. level. A perusal of the annual report will convey little information as to the result of this development work, but I am pleased to say that since the end of the financial year we have been successful in opening up a moderate quantity of average grade ore on both the 14th and 16th levels of the Messina mine. On the former the grade is not high, but, on the other hand, the area exposed is considerable, and as in these bodies we find the better values occurring very largely in the form of bunches of higher grade ore, we find it satisfactory to realize that, even though the grade of the ore so far opened up is low, our chances of ultimately finding reasonable quantities of better grade ore when stoping is commenced appear good. The work at the 14th level has indicated that the Bonanza hanging-wall shoot of ore is pitching west at a much greater angle than was experienced on the levels above. On the 16th level the main drive has penetrated the ore-body described above as having been opened out on the 14th level, and for the first 80 ft. this has averaged between 3½ and 4% copper. As the pitch of the ore-body just referred to will carry the main portion of this shoot on the 16th level to a point further west than our present opening on the 16th, we are hopeful that the development so far recorded on the latter level may be continued to the full extent of the shoot. On the Vogelzang section the shaft was sunk 299 ft., and cross-cuts are now being driven at the 400 ft. and 500 ft. levels to the line of the ore-body. Though some little time is yet necessary before any definite opinion can be formed as to result of this work, I am able to say that since the date of the report a winze below the 250 ft. level has been sunk for a depth of over 45 ft. in ore of very high grade, so that, so far as all the indications go, we would appear to have been justified in devoting so much attention to this section. In the lower levels of the Messina mine there yet remains a considerable amount of work of an exploratory character to be undertaken in the way of testing other shoots of ore worked with some success down to the 10th level. As soon as the labour position permits, it is our intention to proceed with this work.

It is a source of considerable satisfaction to your directors, and I am sure it will be also to you, to realize that, notwithstanding the extraordinarily difficult conditions under which all such work as that at Messina has had to be conducted, our operating costs have shown no great increase for the whole year, and, indeed, in the latter part of the year under review showed and actual decrease. With the gradual increase in the price of all materials, in shipping, and, I may say, in labour also, this, I think, reflects the utmost credit on our staff at the mine. From the latest cables we have received it appears that our ore reserves as at December 31 last amounted to 325,000 tons of 3·4% ore; that our extraction, owing to the lower grade and nature of the ore, was about 75%, and that our actual cost of producing and delivering to the points of consumption was equivalent to about £100 per ton for best select copper. This cost does not include depreciation, railroad guarantee, or debenture interest, but it does include a sum of £5,000 a month for development. The present price for best select copper is £85 per ton, and is liable to fall to a still lower level. On the other hand, the freight from South Africa to U.K. is about £6. 10s. per ton of copper concentrates, or £13 per ton on the copper contained in those concentrates, and we are hopeful that we shall obtain relief in this respect by means of cheaper freight rates, although there is no warrant to expect that they will descend to the pre-war level of 25s. per ton.

Those are the main known factors of the position to-day, and we have had to formulate a policy to deal with them. For the purpose of considering this policy in all its bearings we have had Mr. Emery over to this side, and have thus had the great advantage of consulting with him personally while this policy was being formulated during the last six or seven weeks. It must be evident to you that at the present time, owing to the low grade of the ore reserves, this company must regard itself as being in a development stage, because until we can find considerable quantities of higher grade ore there is not likely to accrue any profit to the company. The question which thus arises is how this development can be effected on the cheapest possible scale, and how we can best utilize our plant and machinery (which is not, generally speaking, an adjunct to a mine in its development stage) for this purpose. After much consideration we propose, therefore, to make improvements in our plant and machinery, and by this means to increase the recovery of copper from 75% to 85%. On the 325,000 tons of ore which we now have in sight, this increase in recovery would amount to about 1,100 tons of copper and, after deducting treatment charges, would give us a sum of between £60,000 and £70,000, which under present conditions of equipment would be thrown away. It has, therefore, become advisable, now that we have an increased tonnage of ore reserves in sight, to make certain expenditure in this direction for the purpose of preventing these losses, but it will, of course, be some time before the effect of this policy will become operative. Owing to increased treatment charges in England, and the high rates of freight from South Africa to this country, it may also happen that we shall increase our furnace plant and produce copper instead of concentrates and matte. This operation can be effected to-day quite as cheaply in South Africa as in England, and we should thus effect a considerable saving in freight as compared with our present and past system of production. These matters, however, are still the subject of investigation and test, both here and in America, where these more modern processes are in use, but we have no reason to doubt their absolute necessity under the circumstances prevailing at Messina. We have already allowed in our costs £5,000 per month for development, and we propose to continue that expenditure on development, both by further shaft sinking at Messina and by lateral development which has lately been giving improved results. We have certain invested funds, the interest on which will approximately meet the interest on the reduced amount of the £171,000 of debentures now outstanding, and we are hoping by these means to make both ends meet. Should this become impossible, we are still adopting what is, in our view, the cheapest method of further investigating the possibilities of the mine, such investigation being considered by our experts both desirable and necessary; and in the event of these investigations proving successful, we shall have a much more economical plant than we have at the present time.

I have endeavoured to put the position of this company fairly and fully in front of you. The prospects in the copper production industry over the whole world are to-day by no means rosy, and costs of production have everywhere increased. Those general conditions we cannot control; we can only endeavour to meet them as far as they are capable of being met, and I have explained to you how we propose to meet them. Without wishing to give you hope which is impossible of realization, I may point out that the position of our mine shows distinct improvement as compared with last year; and although it is not by any means as favourable as it was in the earlier years of the company's history, there are other factors in the position of this company which may turn out rather better than they look to-day. In concluding my remarks, I desire to thank those who have borne the heat and burden of a very difficult time, more particularly the men—and women, too—at Messina, on whom the brunt of the work has fallen. I desire to express my thanks, and I think the shareholders will wish to join me in these, to Mr. Emery, our general manager at Messina, for the excellent work he has done on behalf of this company, and more particularly for that part of it which is not the ordinary work of a mining engineer, the work, I mean, in connection with the negotiations with the South African Government, and I wish gratefully to acknowledge the assistance which my co-directors who sit on the technical committee have given to me in the solution of the many problems which have confronted us, and which have recently demanded so much of their time and attention. I now move: "That the directors' report, together with the balance sheet and accounts for the year ended June 30, 1918, be and are hereby received and adopted."

Mr. J. A. Agnew seconded the resolution, which, after some discussion, was adopted.

The Chairman then proposed the re-election of Mr. J. A. Agnew as a director, which was seconded by Mr. R. J. Frecheville, and carried unanimously.

The auditors (Messrs. Allen Attfield and Co.) were reappointed, and a vote of thanks to the Chairman terminated the proceedings.

MAWCHI MINES, LIMITED.

Directors: F. Holroyd (*Chairman*), C. K. Everitt, H. Greenwood, H W. Hewitt, E. W. Janson, E. L Reynolds, Lt.-Col. P. Wigham Richardson. *Secretary*: J A Henderson *Office*: 18, St. Swithin's Lane, London, E.C.4. *Formed* 1914. *Capital issued*: £221,120; debentures £29,590.

Business: Operates a tin-wolfram mine in the Southern Shan States, Burma.

The fifth ordinary general meeting of Mawchi Mines, Ltd., was held on February 25 at the Cannon Street Hotel, London, E.C., Mr. F. Holroyd (the Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30, 1918, said that a year ago he was able to congratulate shareholders on the satisfactory results of the operations for the year ended June 30, 1917, and this year he was still more pleased to be able to congratulate them on even better results. The gross profit for the year ended June 30, 1917, was £33,000 odd, and for the year ended June 30, 1918, it was £43,000 odd, an increase of over £10,000. The net profit, after providing for all charges, was respectively, 1917, £23,433, and 1918, £33,689 The net result of the year's working was that, after distributing two interim dividends, each of 5%, less tax, and carrying £2,786 to reserve, they had a balance of nearly £8,800 in hand, which, added to the £19,500 in hand at June 30, 1917, gave £28,359 as the balance of profit shown in the balance sheet. The directors only recommended a final dividend of 5%, though there was a profit balance of £28,359 shown on the balance sheet, for the following reason. After the armistice in November last the position of affairs as regards the wolfram industry had undergone considerable changes, and there was a larger stock of wolfram in this country than was needed. The Government had continued to take delivery of these concentrates until the early part of January this year. However, although they had taken delivery, they had not yet received payment for all the parcels, and at the present time they were creditors for about 235 tons delivered between the middle of November and the commencement of January, which represented somewhere about £40,000. Since January they had been notified by the Government that they had ceased to requisition their concentrates on arrival and that they were free to deal with them as they thought fit, subject always to the reservation that they must only sell the wolfram to holders of licenses under the Tungsten and Molybdenite Order, 1917. About a fortnight ago they received a cable from their manager stating that the Shipping Conference had decided to reduce the freight space hitherto allotted to wolfram, and that consequently he would not be able to ship up to the full capacity of his output. The space allotted to them for February was 87 tons, of which 65½ tons were shipped before February 10, and assuming that he was able to ship a further 22 tons in the second half of the month, he estimated that the stock in hand and in transit in Burma at the end of February would be about 180 tons, and all this went to show that for some time—at any rate until shipping conditions became easier—they would have to face the prospect that their output would be in excess of the shipping facilities for its transit to England.

In anticipation that something of this sort might happen at the end of the war, they commenced some time ago certain experiments for the purpose of obtaining a more perfect separation of their concentrates, and he was glad to inform them that so far these experiments had been extremely successful in the laboratory trials. They were now taking steps to have them tested on a commercial scale, and if this test should confirm the results that had already been obtained, it was their intention to equip the mine with a separation plant to carry out this process, and thereby be in a position to ship the tin to the Straits and the wolfram to such markets as might be available.

There was another aspect of the position which they had to take into consideration, and that was the prospect of a change in the price of wolfram. In view of the stocks in sight at the present time, it was quite likely that there would be a drop in the price during the next few months, as compared with the price which had ruled over the past two or three years, and as reasonable business men it was their duty to make provision for this. Consequently, they had to consider that while the stock in hand on June 30, 1918, had been valued, as per the balance sheet, at £38,667, and had been realized at prices in excess of that valuation, it was quite possible that the stocks on hand at June 30 next would require to be valued at a lower figure. Therefore, weighing up all these circumstances, the directors felt that it would be unwise to recommend the payment of a final dividend of more than the 5% mentioned in the report.

With regard to the position at the mine, the manager's report was a most excellent one; in fact the best they had ever had. Not only did the estimated ore reserves at June 30, 1918, show an increase of 9,083 tons as compared with the estimate of June 30, 1917—namely, 84,047 tons, as against 73,964 tons—but the estimated mineral values of these also showed an improvement—namely, 3·95%, as against 3·59%. With regard to the events since the date of the report, the improvement of the Papun Kyauknyat road was resumed after the close of the rainy season last autumn, and they expected that it would be finished before the rains came on again. Unfortunately, this was not a matter over which they had any control, as the work was being carried out by the Government, and although they were pressing as much as they could for it to be pushed ahead, yet they were compelled to be patient and wait events. They were informed quite recently that there was a proposal that the Government should improve the road between Papun and Bilin, which was on the railway from Martaban to Rangoon. If this improvement was carried out and the road became available for transport of their concentrates, it would prove of very great benefit to them, as the distance from Papun to Bilin was very little longer than the distance from Papun to Kemamoung by the Yunzalin Valley route, and the actual distance to Rangoon would be shortened by about 120 miles, thus saving not only cost in transport, but also time. He was pleased to be able to announce that one of the directors, Mr. H. W. Hewitt, would be visiting the mine shortly during a business visit to the East.

Mr. H. Greenwood seconded the motion, which, after a brief discussion, was carried unanimously.

BRITISH BURMAH PETROLEUM CO., LTD.

Directors: Hon. Lionel Holland (*Chairman*), Sir Harvey Adamson, A. McNab, Major E. Seaborn Marks, Edgar Taylor, H. C. Taylor *London Managers*: John Taylor & Sons *Secretary*: John Ponsford. *Office*: 6, Queen Street Place, London, E.C.4. *Formed* 1910 *Capital issued*: £789,191. 4s. in shares of 8s. each; debentures £584,598.

Business: Operates oil lands in Burma, owns nearly all the shares of the Rangoon Oil Co., Ltd.

The adjourned eighth ordinary general meeting of the shareholders of the British Burmah Petroleum Company, Ltd., was held on February 21, at the Cannon Street Hotel, London, E.C., the Hon. Lionel Holland (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the twelve months ended last July, said that there was no new occurrence, no outstanding feature that differentiated the working during the year from the previous twelve months' working. The trading profit again exhibited satisfactory growth. In the twelve months 1915–16 a smart advance was recorded of £109,000, in 1916–17 an additional £39,000, and the present profit and loss account showed a further rise of £79,500. Nor was there any reason to doubt that during the current twelve months they would maintain, if not improve upon, the figures shown. The gross production of crude oil again recorded an increase, being 502,400 barrels, against 442,000. But the consumption of oil for fuel purposes, to provide power for pumping and drilling, was again heavy, some 16% of the gross production; nor was it likely to be a diminishing feature until an installation of electric power had been established for working the Twingone field. Unfortunately, existing prices for material and labour rendered the cost of this at present prohibitive. That they enjoyed an increase in production was due to their having steadily pursued and maintained an increased programme of development work during the years preceding the twelve months under review. It was fortunate that this was the policy followed by the company, for last year was a year of exceptional difficulties, accentuated from month to month, until they threatened to put a stop altogether to the development work upon which their output depended.

There had been a much heavier cost under which field operations had to be conducted since pre-war days; but these factors were so well known that they needed no repetition here. Their increased profits were for the year chiefly accounted for by their larger production and sales of the lighter product, benzine, and by the higher price that it had commanded of late years. With the development of the internal combustion engine, and the vast development of motor traffic, there arose, even before the war, a growing demand for this oil product. Their trade in India and Burma, their home markets, was mainly in kerosene, in burning oil. It was their chief product, the standby of the industry. And here they did not reap the benefit that oil concerns located in other parts of the world enjoyed of an increased selling price. Their principal manufactured product was the cheaper quality of burning oil—the low-grade kerosene—used by the poorer natives, and the Indian Government had fixed a maximum price at which this brand should be marketed. He mentioned last year how the improving market for wax had encouraged them to remodel their wax plant and resume the manufacture of white wax. They augmented their shipments during the year by some 300,000 lb. in weight, and the sales by a couple of lakhs of rupees. The demand for astaki, for fuel oil, in the same way had been emphasized by war conditions. Their output was larger than in 1917 by some 1,800 tons, and although an old-standing contract to supply fuel oil at a fixed figure to the Irrawaddy Flotilla Company, for the flats that conveyed their crude oil from the fields, prevented their gaining the full advantage of an advance in the market price, their sale revenue from this source improved by some £6,000.

On the credit side of the profit and loss account, the balance brought in from revenue account was £371,945, against £292,348 for the year ended in July, 1917, or, with agency fees, interest, and transfer fees added, £381,298, against £299,126 the previous year. The interest derived from the investments, which consisted of British and Indian Government War securities, was higher by about £1,000. Agency fees—the fees and commission received for managing the operations of the Rangoon Oil Company—were up by something over £1,200. Besides allocating a sum of £10,000 out of profits towards the redemption of its debentures, the Rangoon Oil Company, for the first time for many years, was able to declare a modest dividend of 5% upon its share capital, mostly held by this company. The dividend was not paid until November, so it did not appear in these accounts. Dividends received on their shareholding in the Rangoon Oil Company were applied to the purchase of their first debenture stock. The capital expenditure at the refinery was once more quite insignificant. A good deal of useful reclamation work was done, the river wall extended, the fresh water supply enlarged. The only other item calling for notice was reserve account. Last year they were content to put only £15,000 to reserve. This year they felt called upon to make to reserve and contingent reserve, taken together, the very substantial allocation of £110,000. The uncertainty inherent in oil production, the wasting nature of oil wells, the fact besides that a large portion of the profit made was locked up in the business of the company, rendered a substantial general reserve fund a matter of prudence. The board recommended that the dividend to be declared for the past year should be increased from the 7½% paid for 1917 to 12½% free of income tax. The payment would be made on March, and they would propose again to pay an interim dividend at the end of July next on account of the first six months' working of the current year. On what now appeared, looking forward, to be their chief cause for anxiety, he had more than once insisted. The oilfields in the Yenangyaung district were their main source of production, and for years conditions in Yenangyaung had been becoming less favourable. The proved sands were getting exhausted. To maintain their output called for more costly and extensive drilling. The day must come when it would be essential for the stability of the company that it should find new productive fields of commercial value. For the time indeed any immediate cause for anxiety had been allayed by the very favourable results that had followed upon the sinking down to the deeper sands wells in the Beme section of the Yenangyaung field.

Mr. Henry C. Taylor seconded the motion, which was unanimously adopted.

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.SC., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD.,
AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938.* Telegraphic Address: *Oligoclase.* Codes: *McNeill*, both Editions.

BRANCH OFFICES. 420, Market Street, San Francisco. 300 Fisher Bdg., Chicago

SUBSCRIPTION. U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.)

Vol. XX. No. 4. LONDON, APRIL, 1919. PRICE ONE SHILLING

CONTENTS.

EDITORIAL

LADIES are now eligible for membership of the Geological Society. Paleontology, paleo-botany, and crystallography are subjects in which many ladies have shone. It was anomalous that students of the calibre of Miss Reeks and Dr. Marie Stopes should hitherto have been denied entry to the society representing geological science.

TWO months ago we drew attention to the incompleteness of the monthly Board of Trade returns relating to the imports and exports, and called for greater detail of classification of materials, their sources and destination. Chemical manufacturers have also expressed their dissatisfaction with the present system. We are informed that the Board of Trade has the matter under consideration, and that before long many improvements will be introduced in the method of presentation.

SIR William Crookes, who died early this month at the age of 86, was known in mining circles as the author of "Select Methods of Chemical Analysis" and the translator of German works on metallurgy. He was blamed by some for interesting himself in the transmutation of metals, but from the point of view of the modern theory of the constitution of matter he was right in investigating all claims put forward. The science of radio-physics was founded on his discoveries, and the use of atmospheric nitrogen for the manufacture of fertilizers was one of his many suggestions of a practical nature.

IN this issue we print the first half of an article by Mr. V. F. Stanley Low on the history of froth flotation as developed at Broken Hill. Very little has been written on flotation by Australian chemists and engineers, owing to circumstances which need not now be detailed. Nearly everything published has come from American writers, who have been free to talk, and who are always desirous of exchanging experience with others. Mr. Low was manager of Block 10 mine during the period of the development of froth flotation, and he can give us reminiscences based on first-hand knowledge. To experts his article may appear to be elementary or even sketchy, but they will find something in it with a personal touch to interest them. To the unskilled reader his outline of the several processes will be eminently informative, for he gives in a concise manner short descriptions of the most modern developments of methods of treatment. We are also glad to give an Australian manager the opportunity of expressing his opinion of German buyers of concentrates.

CONGRATULATIONS are due to the Cornish Chamber of Mines for the excellent year-book just published. The editor of this book is Mr. Harold E. Fern, the London secretary of the Chamber. It is appropriate that West Country records should be continued by the nephew of the late Mr. J. H. Collins. The year-book is in fact a supplement to Mr. Collins's "Observations on the West of England Mining Region." Particulars of the year-book are given in our Camborne letter.

READERS will be pleased to know that Mr. E. T. McCarthy has continued to write his reminiscences, and that another volume will be published shortly. The original book, which we reviewed in the issue of September last, covered only the first eighteen years of his professional life, and the last incident recorded in it happened twenty-seven years ago. He also informs us that a second edition of the first volume is in the press. The St. Dunstan's Hostel for Blinded Soldiers has already benefited by the sale of the book to the extent of no less than £766, a result on which both the Hostel and Mr. McCarthy may be heartily congratulated.

THE Government has appointed a committee, largely composed of business men, to consider the incidence of the income tax. It is a big subject, with many intricate ramifications. The mine-owner will have a great deal to say when placing his case before the committee. To begin with, it is desirable that in the case of companies the tax should be on "profits" and not on "income." Again, mines should be recognized as wasting assets, and allowance should be made for redemption of capital before profits are taxed. Third, more of the expenditure on development should be debited to current account without taxation than is now possible. Here some difference of opinion may arise as to where development ends and where expansion of the scale of operations begins. While the sinking of a new shaft to tap an ore-body at depth is development, the sinking of a shaft to open a new block of ground is expansion. The sum taken from profits to pay for sinking in the first case should not be subject to tax, but in the latter case it obviously would be taxable. Another source of irritation that should be removed is the basing of the yearly assessment on the average profits of three years. Under these circumstances it may often happen that payments of tax have to be made at a time when the company can least afford to do so, and that the funds which would be normally used for pressing developments are not available, but are annexed by the tax collector. The reforms now demanded must not be regarded as being prompted by the selfishness which seeks to escape taxation, but rather as having for their object the removal of imposts which clip the wings of enterprise.

THE principal Australian lead and copper producers have recently formed a committee having for its object the furtherance of technical education for mining engineers and metallurgists. A fund has been created by means of which two bursaries and two scholarships will be awarded every year at the University of Adelaide. Each bursary will be worth £30 for two years. One will be in connection with mining, and the other with metallurgy. They will be offered to students who have already passed the second year's examinations, and have two more years' work to do in the courses for the Diploma of Applied Science. The scholarships provide for post-graduate courses, and candidates must have completed the four years of the course for the degree of Bachelor of Engineering. Two scholarships will be offered every year, one in mining and one in metallurgy, each tenable for a year and of the value of £150. The holder will occupy himself with study or research at a mine or metallurgical works in order to acquire practical experience in the profession. At the termination of the year the trustees of the fund will see that he secures a suitable position at an adequate salary.

AS Mr. Humphrey Morgans said at the March meeting of the Institution of Mining and Metallurgy, the influence of Mr. T. A. Rickard as an advocate of clear writing is still required among mining men. Mr. Morgans, in commenting on a paper on underground surveying, protested against the author's use of the expression "a two-legged tripod," and also inquired why the mine surveyor referred to his underground operation as "field" work. The word "field" is one of great elasticity with many people, who often treat it as Humpty Dumpty used to do with all his vocabulary, or say, as the school boy did when asked for the difference between a field and a meadow: "a meadow is one that grows grass and a field is everything else." The *Engineering and Mining Journal* often has a couple or more pages of "photographs from the field," and among the pictures are to be found underground views, scenes in the arid deserts and in the crater of a volcano, and photos of blast-furnaces, electrolytic vats, and gas masks. Mr. Morgans and others will be glad to hear that Mr. Rickard has in the press a new book on technical writing. While welcoming the effectual spur of his criticism and advice, many engineers will disagree with Mr. Rickard in detail. For instance, his restrictions on the use of such words as prosecute, install, inaugurate, and contemplate, will not be acceptable to those who take the Oxford Dictionary as their guide. Others will regret that Mr. Rickard, while exhorting us to forsake the careless diction of the mining camps, should use such phrases as "rhetorical rot," "half-baked chunks of knowledge," and "pernicious piffle." But whether they agree with Mr. Rickard in all details or not, engineers cordially acknowledge his great services in promoting careful thinking and clearness of diction.

Business in the Mining Market.

Many factors have combined to hinder the resumption of business since the Armistice. One has been the continuance of Treasury control of new issues of capital and the indecision shown by the new Chancellor of the Exchequer. His first pronouncement was reminiscent of the proverbial unscrambling of eggs, and was received in the City with derision. After a month's consultation with competent advisers, he introduced a more acceptable regulation, namely, that new issues can be freely made if the capital is required for home industries, but that proposals involving the export of capital must still be placed before the Treasury for official sanction. Overseas mining comes within the latter category, and therefore continues under Government restriction. No doubt this regulation entails some occasional hardships. For instance, many investors here are chagrined that they cannot buy New State Areas or West Springs shares in the London market. On the other hand, we should not altogether regret if Treasury control of new mining issues were continued in perpetuity. Indeed, it seems almost flying in the face of Providence to ignore a powerful weapon applicable to the elimination of mining swindles. Treasury control has been exercised with considerable perspicacity during the last year or two, and the same methods would be helpful in the future. Promoters with reasonable schemes would not be hampered, while those who have only nebulous ideas of mining would properly fail to pass their examinations. The only valid objection that can be urged against the system arises from the difficulty of knowing where to draw the line. Some officials would be too exacting and others too indulgent. It might be as it was in the censor's department, where a microscopic view of a British battleship was ruled out of the design for a new coin under the regulation that no illustrations of such ships may be published. For ourselves we would risk any possible evil results of this sort, for the regulation would undoubtedly have a wholesome effect on the shady promoter.

Other aspects of the general question of the protection of the public from mining swindles are provided by the failure of the Stock Exchange adequately to discipline its members as to the nature of the goods in which they deal, and the disinclination of the Government to abolish the outside broker. We are sometimes asked to exert pressure on the outside broker in order to secure delivery of shares paid for. We are more often invited to expose the trashy nature of shares advertised by the outside broker or made the means of raising a little boom on the Stock Exchange. At the present time, in the absence of Treasury permission to issue new capital, the shares of practically defunct companies are being used for the purposes of Stock Exchange gambles. Most of the companies have absolutely no property worth working, and it is doubtful if the controllers have the remotest intention of ever conducting mining operations. The only tangible results are that money is lost by the public, and that the Stock Exchange and mining have their good names undeservedly besmirched. It is a pity that any member of the Stock Exchange can be induced to become a partner in the peddling of rubbish. It is little use the Magazine entering into a campaign to protect people who buy mining shares without knowing the nature of the particular business of each company. They do not in any case buy for dividends, but merely in the hope that the shares will rise in value owing to Stock Exchange influence. The only mining of interest to us is that which has for its object the extraction of metals and minerals, and our advice as to prospects of any particular project from that point of view is always at the disposal of our readers. But prognostication as to movements in the value of shares arising from wire-pulling in the market and on the Stock Exchange does not come within the scope of the Magazine. Our general attitude on this subject may be indicated by the expression of the wish that the pull on those wires was not quite so strong.

Improving the Lot of the Worker.

The campaign for improving the pay and surroundings of the worker received a tremendous impetus from the war, and, in this country, and in other component parts of the Empire, it has been generally admitted that further serious efforts must be made in this direction. Parliament and the average citizens were prepared to do much to improve working conditions, but would have thanked the Trades Unions for less precipitancy than they have shown. It would have been more conducive to good results and to the preservation of temper if the labour questions had been postponed until peace had finally arrived. But a wilful man must apparently have his way, and the masters will have to cudgel their wits to find some off-set against the increased wages bill. The solution of the matter in the domain of mining must be the more liberal expenditure of capital on the development of new ideas, the greater application of underground machinery at the mines, and the freeing of the land from the present arbitrary system of ownership. The conditions in England still exhibit some features of old feudalism. The success of operations of all sorts has depended on a plentiful supply of cheap labour. The landowners' rights and privileges stand in the way of reforms, both social and in business. It is not so much that the landowners are callous, but that they are bound by family trusts which, by law, prevent them from expending capital or embarking on any enterprise of a social and unremunerative character. The shackles of the family trust also make themselves felt in many businesses. In a new country, land tenure has fewer restricting complications, and labour is scarce. Thus the housing problem is simplified and the conditions improved, while the use of machinery can compensate for the necessary increase of wages. There are many firms in this country who have been fortunate enough to have the opportunity of freeing themselves from the influence of the remnants of feudalism. The communities at Bessbrook, Barrow in Furnace, Port Sunlight, and Bournville may be mentioned as examples of many others. As regards the housing of coal miners, the Kent operators have shown what can be done to improve the accommodation, and the little village of Elvington is as pleasant a place as the Hampstead Garden Suburb.

Amid the anxious events at home it is pleasant to turn to some of the betterment enterprises in Australia. Last month the Broken Hill Proprietary company obtained sanction of the court to alter its articles of association in such a way as to permit the expenditure of £50,000 with this object in view. The Broken Hill Associated Smelters' company has done much recently to improve the lot of the worker, and we have given details in several issues during the past year. But we particularly wish on this occasion to record what has been done by the Wallaroo & Moonta Copper Mining & Smelting Co., basing our remarks on a public statement made by the manager, Mr. H. Lipson Hancock.

As our readers are aware, the mines of this company are at Kadina and Moonta, in the northern part of Yorke's Peninsula and 120 miles or so from Adelaide, while the smelter is on the sea-shore at Wallaroo. The mines have been worked for over 50 years, and for the latter half of the time, especially since the amalgamation of the two companies, there has been no serious disagreement between masters and men. The wages are based on an agreed minimum, above which extra bonuses are given according to rises in the market price of copper. In many ways this sliding scale is preferable to a system founded on the sharing of profits, for it avoids the dispute as to what constitutes a profit. The underground men work 44 hours per week on day shift, and 40 hours on the afternoon and night shifts. No mining is done between 12 noon on Saturday to 7.30 a.m. on Monday, and the afternoon and night shifts work only five days, though receiving the same pay as the day shift. The houses built in recent years are of a good type, with gardens, and unoccupied land affords free grazing for cattle and horses. The men usually own their houses. In the earliest days the country was bare and the conditions of existence were dreary enough, but these have been gradually changed, and the dwellers have every advantage of a modern town. There are libraries and reading rooms, halls for entertainments, gymnasiums, football and cricket grounds, girls' clubs, and playgrounds for the children. The schools are under State control, and range from primary to high and technical. Churches, Sunday schools, and friendly societies flourish. Medical service is provided by the company, and the men subscribe to the funds required. Compensation for accidents comes under the law, but additional contributions come from both the company and the men, especially when necessitous dependents are left behind as the result of a fatal accident. Altogether the communities presided over by the company are singularly happy, and the methods and principles on which they were established might well be studied by other employers.

Water Power in Scotland.

Some disappointment was felt when Parliament and the Government decided last year to refuse the Bill promoted by the British Aluminium Company for the expansion of its hydro-electric installations in Scotland. It will be remembered that the company wished to utilize the waters of Lochs Trieg and Laggan, as the capacities at Kinlochleven and Foyers were below the requirements of the expanding industry. It was felt by the Government and many private individuals that this enterprise should be postponed until the water-power resources of the country should be investigated from a national point of view. There are many interests to be considered when negotiating for the use of natural water supplies. The landowners, the residents, and the local governing bodies all have a say in the matter, both as regards the utilization of the water and the erection of electric transmission lines, and finally Parliamentary powers have to be obtained. The general opinion was that complicated questions of this character could be better handled by a government department, which, naturally, has more influence than the individual applicant in combating the demands of the people with vested rights. It is obviously best to start on correct lines at the outset, and thus avoid the over-capitalization which the country would have to shoulder should the principle of nationalization be accepted at a later date. The railways would be in a happier position now if the purchase of land and rights of way had been publicly controlled from the outset. The same may be said of such enterprises as the Manchester ship-canal, which was blocked for many years in Parliament, and ultimately saddled with a big capitalization due to the requirements of the landlords, and, incidentally, of the railways.

When the scheme of the British Aluminium Company was withdrawn by request, a committee to consider the water-power resources of the British Isles was appointed by the

Board of Trade, and four engineers of standing were deputed to examine the various plans already suggested throughout the kingdom, and to make personal examinations and submit their own proposals. Their duties were much simplified and assisted by the work done and the proposals made by earlier bodies and by industrial pioneers. The Conjoint Board of Scientific Societies had already prepared a report on the subject, covering the British Empire, and to Messrs. Vaux Graham and Alexander Newlands is due a large share of the credit for pioneer work. In preparing the new campaign, the committee decided to examine the Scottish resources first, as they are obviously the most promising. In the English Lake District, the Pennine Chain, and Wales, many of the lakes and catchment-basins are already employed for providing the water-supply of towns, and the probability is that these demands will increase, so that these areas require more prolonged examination before any opinion can be given as to their value as sources of hydro-electric power. The committee also decided that the study of the Irish resources should be handed over to a special sub-committee.

The first interim report of the committee was published last month, and from it we find that the water-power resources of Scotland are very much greater than was originally supposed. The area covered by the report covers parts of three counties, Inverness, Perth, and Argyll. Details of nine schemes are given in the report. The aggregate power that can be developed by their means is estimated at 183,500 electrical horse power, corresponding to an output of 1,200 million units per year. The generation of this power would save the combustion of 1,850,000 tons of coal per year. This is a very difficult tale from that of the Royal Commission on Coal Supplies of 1905. It was then stated that the harnessing of the whole available water in the British Isles would only save 1,200,000 tons of coal per year. The latter figures were no doubt largely based on guesses, or at any rate on very crude investigations. We can only say that the figures now published confirm our own impressions, gained by personal knowledge of the likely spots in Scotland, Wales, and elsewhere, and endorse the many statements in our pages advocating the greater use of hydro-electric power in this country.

The regions where it is proposed to develop the water resources are full of romance and beauty. The mountains, rocks, streams, and lakes provide grand, if gloomy, scenery. The birches and the pines and the ferns thrive gloriously. The salmon fisher and the deer-stalker are in their element. Old memories are revived by visiting the passes of Glencoe and Killiecrankie, and the spirits of Bonny Prince Charlie and Macbeth still hover over the scene. Those whose hearts are in the highlands may protest against the desecration of both land and water, but it must be remembered that the generation of hydro-electric power contaminates neither river nor air, and that the industries established by its means will introduce greater sources of sustenance for the population than is provided by farming operations in a damp and chilly climate.

Of the nine separate schemes, the largest deals with the waters of Lochs Ericht, Rannoch, and Lydoch in north Perthshire, running into the Tummel river. This is good for 42,000 e.h.p. The next is the scheme promoted by the British Aluminium Company, to utilize Lochs Laggan and Trieg, in south Inverness, flowing into the Spean river, and estimated to generate 38,000 e.h.p. The third will generate 31,000 e.h.p., and will employ the waters of Lochs Affric and Mullardoch, in the northern part of Inverness. The fourth will generate 27,000 e.h.p., and will employ the waters of Lochs Quoich and Loyne in western Inverness. The others are on a rather smaller scale, the horse power ranging from 7,200 to 12,000, the localities being Loch Awe in Argyll, Kilmorack falls near the town of Inverness, Loch Clunie and Morriston river in western Inverness, the Lower Farrar river in northern Inverness, and Loch Monar, also in northern Inverness. It is estimated that the cost of the installations will total £7,075,000, or £38 per e.h.p., the latter being an average of figures ranging from £17 to £45. The cost of generating the current is estimated at 0·15d. per unit. As regards the method of employing the current, there are a number of important towns and industrial centres within a distance of eighty miles, such as Glasgow, Edinburgh, Aberdeen, and Dundee, while, locally, there are plenty of sites on the seaboard suitable for the erection of electro-metallurgical and electro-chemical plant. In conclusion, we may say that the committee does not confine its attention to big schemes, but that it also impresses on the manufacturer and the public the fact that there are innumerable small sources of water-power available throughout the country only requiring a little expenditure of capital and involving a minimum of running expenses. This aspect of the question was well presented in an article in last month's issue.

REVIEW OF MINING

Introduction.—Peace is still postponed; labour troubles at home, if less acute for the present, are by no means settled; the out-of-work donation prevents a general resumption of trade activity; the position in Russia causes much anxiety. In mining, things are dull, as the demand for metals is low and the war stocks are high. The owners of home non-ferrous mines are discouraged by the want of sympathy shown by Government departments. The export of gold from this country has been prohibited except under special licence, a step rendered necessary by the withdrawal of control of the American exchange. The price of silver in this country is now ruled by the American exchange. The Amalgamated Properties of Rhodesia has lost its case in the House of Lords.

Transvaal.—Labour troubles and political unrest are causing difficulties, particularly in Johannesburg, and the public services have suffered from the action of workers' unions which desired to take control in the fashion of the Bolsheviks. At the time of writing a settlement seems to have been reached. At the mines, the supply of native labour is increasing. On the other hand, the position of the low-grade mines continues acute owing to the absence of profit and the prospect of losses, and some announcement relating to stoppage may be expected unless the outlook becomes more settled.

At Modderfontein East the reef has been cut from No. 3 shaft, the northern of the two shafts sunk to develop the new ground. At the point of intersection, the ore averaged 8 dwt. over a reef width of 33 inches. It is proposed to raise further working capital by the issue of debentures. In the first instance, £200,000 debentures bearing 6½% interest are to be issued, redeemable at £105 on July 1, 1921, and convertible into shares. If developments warrant, a further £300,000 will be issued on the same terms. During the currency of the debentures no profits will be distributed except the share due to the Government under the lease.

At the Geduld mine, the amount of ore milled during 1918 was 513,200 tons, an increase of 87,500 tons over 1917, and 190,220 tons over 1916. The yield of gold was worth £747,905, or 29s. 1d. per ton, and the working cost was £513,664, or 20s. per ton. The reserve at December 31 was estimated at 2,510,000 tons averaging 7·5 dwt., as compared with 2,200,000 tons of the same assay-value the year before. By the adoption of the cementation process, the inflow of water has been reduced by about one quarter.

The report of Modder Deep for 1918 shows a sound position. The tonnage milled was 506,100 tons, the yield £1,035,272, and the working cost £441,621. The yield per ton was 40s. 11d., and the cost 17s. 5d. The shareholders received £487,500, being at the rate of 97½%. The reserve at December 31 was estimated at 3,450,000 tons averaging 8·8 dwt., an increase of 130,000 tons and 0·1 dwt. over the previous year.

The Rand Selection Corporation has bought from the Custodian of Enemy Property 122,433 shares in the company held by him on behalf of enemy shareholders, the purchase price being £3. 13s. 6d. per £1 share. The directors propose to distribute in the form of a dividend 42,206 of these shares, being at the rate of 8 shares for every 100 shares held and to offer the remainder for sale to shareholders, at the rate of 15 for every hundred held.

The New Era Company, one of the Consolidated Mines Selection group, and holding a variety of shares in Far East Rand and other companies, has purchased 61,392 enemy shares from the Custodian of Enemy Property at 8s. 9d. per 5s. share. These are to be distributed as a bonus to shareholders, being 18 shares for every 100 at present held.

The Southern Van Ryn company announces that a vertical shaft is to be sunk to develop the property at depth. The property is in the southern part of the Far East Rand, and Mr. W. Bleloch is the pioneer. A year ago the Consolidated Gold Fields took a large interest, and later assumed technical control. Two bore-holes were put down. These cut the reef at 2,601 ft. and 2,860 ft. respectively. The assay values were low, but Mr. C. D. Leslie, the Gold Fields engineer, was not discouraged, holding that the chief function of the bores was to indicate the depth at which the reef lies.

Two other companies operating in the southern part of the Far East Rand are the New Albion and the Newdwarf. The first of these holds an option on Valsfontein farm, and an interest in Dr. Sauer's exploration on Boschhoek. The second holds options on Klipstapel and Wolfhok. There is no geological evidence at present that these options are of any value.

Daggafontein is to increase its capital by the creation of 300,000 new shares. It is felt that the time has now arrived for defining the company's mynpacht and for securing additional mining rights from the Government in order to make a mining property of suitable size.

Rhodesia.—The output of gold in Rhodesia continues to improve, though the after-effects of the influenza epidemic are still visible. The return for February was £220,885, as compared with £211,917 in January, £136,780 in October, and £232,085 in February, 1918. At the Wanderer, no development has been done lately owing to labour shortage, and the ore milled has been drawn from the richer sections of the mines. A cable comes from the Gaika relating to further hopeful developments: a south drift on No. 3 level from No. 16 shaft driven on the Rubble reef has passed for 17½ ft. through ore averaging 31 dwt. per ton across 38 inches. The Eldorado mine is expected to stop milling next month, owing to the reserves being exhausted.

The judgment of the House of Lords in the celebrated case of the Amalgamated Properties of Rhodesia against the Globe & Phœnix confirms those of the Court of Appeal and of the Court of Chancery, and the Amalgamated Properties finally loses. Many people are inclined to blame Amalgamated Properties for undertaking this litigation, but our own belief is that if the case had been argued before courts in a country accustomed to the Apex Law the geological evidence would have led to a different verdict.

The Rhodesia Broken Hill Development Co. reports that the Rhodesia Lead & Zinc Syndicate, which undertook development and the erection of lead smelters, has been placed in voluntary liquidation, the company having acquired the whole of the shares and the syndicate having redeemed its debenture issue of £60,000. Subsequent exploration by bore-hole was done by the Central Mining & Investment Corporation, and the results have been so favourable that the corporation will exercise its option to take up shares, provided Treasury consent is obtained. At No. 1 kopje the bores indicate the existence of ore containing 100,000 tons of lead and 25,000 tons of zinc. At No. 2 kopje there is 300,000 tons of ore averaging 32% zinc. Conditions indicate the existence of much more ore, and the consulting engineers, Messrs. Hooper, Speak & Co., recommend a systematic geological examination. The François method of cementation is to be adopted for stopping the inflow of water. A third lead furnace is to be erected, bringing the output to 1,500 tons per month, and zinc smelting is to be undertaken.

The Shamva company announces that another ore-body has been discovered. This is on Cymric Hill, and it averages 3·8 dwt. per ton over 30 ft. At the Shamva ore-body, the reserve is estimated at over 2,000,000 tons averaging 4·3 dwt. The new ore-body was found in the course of the prospecting work undertaken on the recommendation of the late Dr. G. S. Corstorphine.

West Africa.—The output of gold during February was £112,616, as compared with £104,063 in January, and £112,865 in February, 1918. The effects of the influenza epidemic seem to have passed away, as all the mines report a normal output.

Australia.—The Broken Hill South is arranging to take 70,000 shares in the Electrolytic Zinc Company of Australasia. The present shareholders in the latter are Amalgamated Zinc (De Bavay's) with 280,000 shares, and the Zinc Corporation with 70,000 shares. Amalgamated Zinc produces the zinc concentrate from the South mine's zinc tailing. Eventually £1,000,000 will be spent on the electrolytic zinc plant and on the establishment of industries utilizing the zinc. At present the output of zinc is 90 tons per week, and this is to be raised to 100 tons per day. Conditions in Australia, particularly those in connection with labour, favour electrolytic production rather than distilling methods. In this connection it is of interest to note that the Sulphide Corporation cannot get sufficient English workmen for the smelting works at Seaton Carew, Durham, and has received permission to import Belgians for the purpose.

An important discovery of alluvial tin is reported from Cox's Bight, at the extreme south of Tasmania. Here the beach is wide and extends for miles at the foot of granite cliffs. Bore-holes in the sand show tin to a depth of over 50 ft. Local enthusiasm compares the deposit to that at Tongkah Harbour.

India.—The yearly reports of the Mysore, Ooregum, and Nundydroog all show poor results of development in depth, and at the Mysore the yearly output has been adversely affected thereby. The depletion of the ore reserves at Mysore and Nundydroog has been considerably arrested by the stoping operations providing more ore than was called for by the estimates. Rock-bursts are gradually becoming more troublesome. The latest news from Ooregum shows that better results are now being obtained in depth in Oakley's section.

Malaya.—The renewal of mining activities after the war is being postponed owing to labour unrest at home. A characteristic instance of this is provided by the case of the Ipoh Tin Dredging Co. This company has a large area of payable ground on the opposite side of the railway to that now being worked, and has considered the question of providing a second dredge in order to work it. The tenders submitted by builders in this country, however, contain so many reservations based on the cost of materials that the directors have decided not to fix any contract at present.

Siam.—The Tongkah Harbour tin-dredging enterprise appears to be assured of a new lease of life by the results of boring in the outer harbour. At the present time, No. 6 is the only dredge that can withstand the rough weather often experienced in the outer harbour during the monsoon, and it is proposed therefore to build a new dredge, specially designed for the purpose, whenever a contract can be placed to advantage. We take the opportunity of drawing attention to the history of this enterprise given in our last issue, and to the account of other Australian tin-dredging operations in Siam and Malaya appearing elsewhere this month.

Spain.—The mines of the Cordoba Copper Co. are to be closed temporarily owing to the uncertainty in the copper market. During 1918 the income and expenditure were approximately equal, but since then conditions have become worse and losses have been made. As recorded a year ago, the directors decided to abandon the San Rafael and Eastern sections owing to disappointing results, and to pay special attention to developments in depth in the San Lorenzo section. This shaft has been sunk to 1,018 ft., and drifts east and west have been started. In addition, a cross-cut has been driven southward to the Excelsior lode, which yielded much ore at and above the 850 ft. level. Scarcity of labour greatly impeded this work. During 1918 the ore supply for the smelter was largely drawn from reserves. The ore raised during the year amounted to 46,369 tons, averaging 2·39% copper. At the end of the year the reserve stood at 64,794 tons averaging 2·23%, as compared with 99,139 tons averaging 2·16% at the end of 1917.

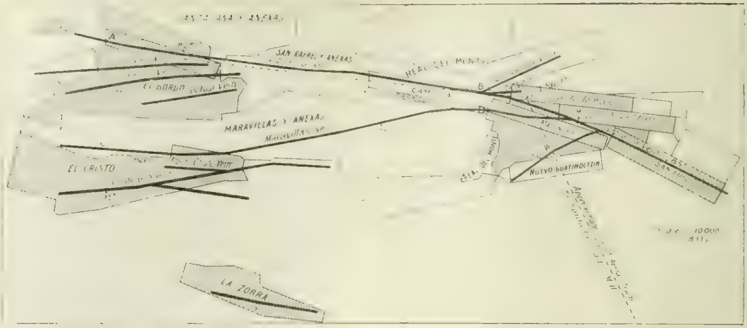
Russia. — The directors of the Russo-Asiatic group of companies has issued a brief statement as to the position at the various mines. Several departments at Kyshtim are being operated under the direction of the Siberian Government, acting through the company's management. Early in March the advance of Bolshevik forces into the Southern Urals necessitated a temporary withdrawal of the staff from Tanalyk to Omsk; recent movements on the Siberian front south of Ufa and west of the Urals indicate that the mine is once more in the company's possession. At Ridder the railway and engineering shops are working, and producing a revenue which is applied toward the general maintenance of the property. At Ekibastus the coal mines are in operation, and it is estimated that the income will cover expenditure; the stock of zinc has been sold at a remunerative figure to the Siberian Government; the river fleet has been repaired and put in condition for summer traffic.

Canada.—In no place has the gold-mining industry been so favourably affected by the cessation of hostilities as at Porcupine. Large numbers of men released from munition manufacture are flocking to the mines. The Dome Mines, which were closed owing to the scarcity of labour and the consequent impossibility of meeting expenses on low-grade ore, are to start again next month at the full capacity of 40,000 tons per month. With the death of Captain De Lamar, the controller, it is to be hoped that the policy of secrecy will be abandoned.

United States.—The output of iron ore during 1918 is estimated at 69,712,000 tons, as compared with 75,288,000 tons during 1917. Of the total, 41,870,000 was raised in Minnesota, 17,131,000 tons in Michigan, 5,745,000 in Alabama, and smaller amounts in Wisconsin, New York, Pennsylvania, New Jersey, Colorado, Tennessee, Virginia, and Georgia.

The mine of the Goldfield Consolidated, in Nevada, was one of the most spectacular of all gold mines. The total production was over seventy million dollars, and the dividends have totalled \$28,000,000. During the last two years the policy of letting to tributers has been gradually extended, until the property left for the company to work did not justify the maintenance of an administrative staff. It has now been decided to give a five years' lease of the whole mine to an independent development company, on a royalty of 20% of the output.

During 1918, the Ray Consolidated produced ore and concentrate containing 38,800 long tons of copper. The grade of the ore for the whole year is not given, but for the last quarter of the year the figure was 1·62%. At the Chino, the concentrate and ore produced contained 35,400 tons of copper. During the last three months of the year the grade of the ore was 1·7%. At the Utah Copper, the copper content of the concentrates and leaching-plant precipitates was 80,000 tons. The average grade of the ore treated during the last quarter



PLAN SHOWING THE NEW PROPERTIES ACQUIRED BY THE SANTA GERTRUDIS COMPANY.

of the year was 1·23%. The cost per pound of producing copper at these three mines during the last quarter was 19·3 c., 18·1 c., and 17·88 c. respectively.

It is announced that Messrs. Hayden, Stone & Co. have bought 34,644 shares out of 70,000 in the American Metal Company at a price of $114 per share. Thus the old German control passes into the hands of the Utah-Nevada-Arizona porphyry copper group.

The output of carnotite in the United States during 1918 is estimated by Mr. H. C. Meyer, of the Foote Mineral Company, at 8,450 tons, averaging 2% uranium oxide and 3½ to 4% vanadium oxide.

Mexico.—In our issue of August last we mentioned that the Santa Gertrudis company had acquired leases of additional silver-mining properties at Pachuca, three or four miles to the north of the property now being worked. Further particulars are now available, and we are able to give an explanatory map of the claims and the lode systems. The El Bordo company, from which the leases have been obtained, has worked the El Bordo mine on a fairly large scale; the El Cristo has been a smaller producer; while the Malinche is of considerable speculative value. The El Bordo has a reserve of 300,000 tons averaging 17 oz. silver and 1·6 dwt. gold. The plan is to increase the scale of development and to raise the daily output to 500 tons. The El Cristo has a reserve of 125,000 tons averaging 9·5 oz. silver; development will be started at a later date. The Malinche never gave particularly good results when worked by the El Bordo company, but it is believed that the rich zone characteristic of the district at depth had not been reached. It is now proposed to sink the two shafts to 1,000 ft. and to drive cross-cuts. As regards the lode systems, it will be seen from the plan that the Viscaina lode passes through both the El Bordo and the Malinche properties. Between the two, the lode is in the San Rafael and Real Del Monte mines, where it has yielded enormous profits. Another celebrated lode is the Maravillas, which has been highly profitable in the Maravillas company's ground. This lode enters Malinche and joins the Viscaina. One of the cross-cuts mentioned will be driven to this junction of the lodes. The productive zone of the Viscaina lode near the Malinche boundary is 50 ft. wide and averages 20 oz. of silver per ton, and the Maravillas lode near the Malinche boundary is 20 ft. wide averaging 30 oz. Ownership of a property adjoining a bonanza does not necessarily imply the possession of a fortune, but in this case it may be said that Malinche is a property of undoubted speculative value. We published an article on the Pachuca district, written by Mr. John M. Nicol, in our issue of February, 1910.

Bolivia.—Yearly reports of the Aramayo-Francke Mines, working tin-wolfram-copper-silver mines, do not give any particulars of output, these details being usually presented in the Chairman's speech. The report for the year ended May 31 last shows a profit of £273,353, out of which £268,690 has been distributed as dividend, being at the rate of 45%. We shall deal with the output next month.

Colombia.—The Oroville Dredging Company is acquiring a lode-gold property in Colombia. Hitherto the company has been identified with alluvial mines, the Pato and Nechi being already well known to our readers. The new property is 40 miles from Pato.

AT THE ANTHRACITE MINES, SOUTH RUSSIA

IN THE EARLY DAYS OF THE WAR, JULY, 1914, TO DECEMBER, 1915

By DR. A. L. SIMON.

The Author gives his experiences in the Anthracite mining-district, South Russia, during the early days of the War, discussing social and racial conditions, and describing a number of interesting engineering problems.

IN the early summer of 1914 I was in Siberia inspecting mines in the Yenisei, Altai, and Ural districts. Siberia was then bocming. Railways and river steamers were overcrowded. So were the hotels, places of entertainment, and shops. At the shops the pressure of eager buyers reminded me of sale days in Oxford Street. The crowd was, however, of a different type. It consisted chiefly of peasants who had made money by selling butter, eggs, cheese, etc., to the foreign trader in that land of plenty. How different it all looked when I revisited these same parts in spring of 1916!

I returned to St. Petersburg, as it was then called, toward the end of July, and applied for the necessary Russian military permit to visit Tnrkestan professionally. On arrival in the Russian capital, the Sarajevo murder and its possible consequences formed the chief topic of conversation. The tragic events that led to the various declarations of war followed in quick succession, and then innumerable difficulties arose as to the home journey. While endeavouring to select a route that presented probabilities of reaching England, I was offered a post as resident technical adviser to an anthracite colliery in Southern Russia belonging to an English company. I knew the property well, having reported on it several years previously. I accepted the position, and proceeded to the mine forthwith. The journey south, which took three days, showed the country to be in a normal state of mobilization. At the stations crowds of reservists were waiting. Their families were with them, and when eventually the reservists boarded their trains, extremely pathetic farewell scenes were witnessed.

At the mine the small English staff seemed to be perturbed, chiefly owing to the fact that there were no funds whatsoever to meet the most pressing liabilities, such as workmen's wages and bills for foodstuffs. The London office of the company, on being appealed to, remitted the money, and by the end of August the regulation pay-day could take place. Another cause for nervousness was due to the serious blundering of the local police during the first days of mobilization. The reservists employed at the mine were ordered by the police to assemble one morning at 5 a.m. They were marched off to the railway station, where they arrived at 6 a.m., feeling very hungry. The train to take the men away was not due until 11 a.m. The men from the various mines of the district, several hundred in number, clamoured for food and drink, and, as it was not forthcoming, got impatient, broke into the various booths near the station, and secured in addition to foodstuffs considerable quantities of vodka. They all got drunk, and in the first excitement decided to return in a body to their respective mines and smash everything. Fortunately the mines were a couple or more miles from the station. During the return journey one man collapsed after another, and eventually they all lay asleep by the roadside. The police picked them up and put them into all kind of vehicles, brought them back to the

THE AUTHOR

station, beat them most unmercifully with horsewhips, and entrained them eventually for their various destinations. During the first days of the Russian revolution many a policemen paid with his life for such misdeeds committed while he reigned supreme. The workmen remaining at the mine, some 1,500 in number, were fairly restive too. Their wages for July had not been paid, and they wanted to know what was going to happen in August. Many angry scenes occurred, but when they could be told that the August payday would take place all anger and effervescence vanished for the time being. The mine assumed its pre-war conditions, which, from the technical point of view, were far from satisfactory.

To better understand the prevailing conditions and various alterations which became necessary, I will give a short description of the property and its equipment. The area for which the company holds the exclusive mining rights approximates ten thousand acres. It is of irregular shape, and extends roughly for 3 miles from east to west and 5 miles from north to south. Of the various coal seams on the property five have been definitely located, but three only are being worked. These are No. 1, No. 2, and No. 6 seams. They strike from east to west and dip to the south at angles varying from 9° to 22°, all flattening out in depth. No. 1 seam, the uppermost of the series, has been worked extensively from three incline shafts, No. 1, 3, and 5, each having a length of some 300 fathoms and all three provided with endless haulage. While No. 3 and 5 shafts start from the surface, No. 1 incline starts from a point some 20 fathoms below the surface, connection with the latter being established by a small vertical shaft. No. 2 seam, which lies some 18 fathoms below No. 1 seam, has been made accessible through cross-drifts from the deeper workings of No. 1 seam. No. 6 seam is being worked from one incline shaft situated some 2½ miles to the north of No. 1 shaft; it is provided with single-line tail-rope haulage.

The most important surface installations are in the immediate vicinity of No. 1 shaft and consist of a boiler house with 5 Lancashire boilers, and a new power house with Curtis turbine and 800 k.w. generator. A medley of 4 smaller steam engines and electric generators constituted the old power plant, which was used whenever the main power station had to be stopped. There is also a carpenters' shop, mechanical shop, smithy, and hauling engine for No. 1 vertical shaft. Other buildings and structures near No. 1 shaft are the general office, the trading store and bakery, the bath house, several barracks for workmen, quarters for married men, a cinema, storehouses, and stables.

The surface installations near the other three shafts chiefly consist of workmen's quarters, the local superintendent's house, winding engine house, and coal screening plant. Power is transmitted by overhead wires at a tension of 2,000 volts to wherever required, and for local use is transformed to a tension of 500 volts, except in the case of No. 3 winder which is driven by the original current.

Each mine is under the direct supervision of a Russian mine foreman, a "Steiger." He holds a full power of attorney for his shaft and is personally responsible to the authorities for any accidents or mishaps. Similar powers of attorney are held by the chief mechanical engineer, the architect, and the manager of the trading store for their respective departments. This course is absolutely necessary, as it tends to reduce breaches against the innumerable mining regulations or civil laws which, if committed, mean that somebody has to be punished, the punishment generally being quite out of proportion to the offence. Thus a workman finding a black beetle on a piece of bread complained to the police, with the result that the stores superintendent got a month's imprisonment and the surface manager for the same offence ten days. Fires of any description always entailed heavy penalties. For instance, a beam in the boiler house caught fire, which was subdued without any damage beyond the beam being scorched. Result, three weeks' imprisonment for the chief mechanic. Such sentences are, of course, appealed against, which means endless litigation extending over years. In the two cases mentioned the revolution intervening quashed them. Criminal law was equally queer in its administration, as an example will illustrate. A timekeeper, through the insertion of fictitious names in the pay sheets, had managed to misappropriate some 2,300 Rs. The police on being informed arrested him. His father paid the amount claimed by the company into court and the man was set free pending his trial before a jury. The day before the trial he surrendered to his bail, whereupon the sum deposited was refunded to the father. At the trial the jury, consisting of peasants, acquitted the man on the ground that the company was rich enough to pay. He left the court without a stain on his character, while the company had no redress.

The technical conditions were difficult to remedy owing to the war which caused hindrances from the beginning and got worse as time went on. I will deal with them under various headings.

MINE WATER.—Shortly after arriving at the mine the lowest level of No. 1 shaft was flooded. This meant that none of the workings could be reached, and the pit stood idle for about two weeks. This, it appears, had been happening periodically, and continued to occur while repairs and alterations were carried out and fundamental defects removed. The amount of water that had to be pumped from the shaft under normal conditions was 500 gallons per minute. During the spring thaw or after periods of rain this amount increased very considerably and could not be coped with, although the total capacity of the pumps was far in excess of any likely quantity. Of the three electrically-driven pumps the largest one could not be used owing to a broken crank shaft, and of the two steam-driven pumps of the Worthington type the largest one was suffering from defective valves and both from inadequate supply of steam. It took over twelve months to procure a new crank shaft, thermit for a temporary repair being unobtainable, and it took over six months before an adequate steam supply was available. This delay was due to deficiencies of the boiler plant. They will be dealt with later. The breaking of the crank shaft was at first accounted for through insecure foundations. Eventually it was ascertained that undue resistance in the pipe-lines was the cause of this and other breakages. The pipe-lines were found to be badly furred and partly choked through the malicious insertion of mine sleepers. All the pumps were connected with a general air vessel from which three 5 in. pipe-lines 600 yards long led to the surface. The wrought iron pipes with muff connections were laid in a drift running parallel to the main incline shaft, and were extremely difficult of access on account of rock debris covering them, and also on account of the presence in that drift of an uncovered steam pipe which was supposed to supply the Worthingtons with power; instead of doing that it caused an unbearable temperature in the drift, and owing to occasional leakages provided a steamy atmosphere impenetrable to the eye. The steam cylinders of the pumps chiefly received condensed water instead of steam. Eventually the drift was cleared of debris, the steam pipe was covered with a mixture of clay and straw, and a new 7 in. pipe-line, consisting of flanged wrought iron pipes, was laid. The old pipe-lines were then gradually removed, cleaned, flanged, and re-laid. In the worst cases the furring was so thick that a bare 2 in. passage was left clear in 5 in. pipes.

GENERAL VIEW AT NO. 1 SHAFT OF ANTHRACITE COLLIERY

The pumping capacity of the underground installation was added to through the installation of a 5 in. centrifugal sinking pump capable of working against a head of 250 yards, which was discovered tucked away in No. 2 seam where it worked two hours a day against a head of 20 yards, its delivery pipe having been reduced from 5 in. to 2 in.

Another addition to the pumping capacity was created by locally transforming an old steam-driven Snow pump into a belt-driven one, and installing it near the bottom of No. 3 shaft, from whence it delivered direct to the surface. The alterations and repairs proved efficient, the mine never having been flooded since they were carried out.*

At No. 6 shaft considerable trouble with pumping was caused through the acid nature of the water. The ordinary pump with cast-iron cylinders was perfectly inadequate, being eaten away in about a year's time. A centrifugal Boving pump with bronze lining, ordered in England, was received after much delay. It was discovered at the railway station, but the way-bill having gone astray delivery was refused for several months. It was installed after my departure from the mine in December, 1915.

The fluctuating amounts of mine water which have to be dealt with and which necessitate pumping installations of a capacity three times as large as for normal requirements are due to wrong methods having been adopted when starting the mines.

The anthracite seams have no proper outcrops and do not appear at or near the surface of the soil.†

The coal is found at a depth approximately corresponding to the permanent water level, which is that of the creeks in the ravines or gullies cutting through the country. The remnants of a seam can, however, readily be located and identified in prospecting trenches deep enough to have reached the undisturbed soil. These remnants consist of a thin layer or seam of a white or pinkish clayey material, which when followed into depth abruptly changes into the coal seam. The coal in the first few yards of further sinking has a reddish hue, the pyrites in that part having been oxidized. Beyond this transitory stage it is found without any sign of alteration to the pyrites. It is therefore reasonable to assume that the disappearance of the seam from its former outcrop to the natural drainage level is due to surface water circulation and that a drainage channel is established by the remnants of the former seam. This is corroborated by the fact that coal pillars left standing as supports for drifts, particularly in seams with high sulphur contents, give way after a short number of years. The pillars left standing for the support of No. 6 drift, opened in 1908, began to crumble away in 1914 and gave considerable trouble in subsequent years through being crushed. The remedy is simple from the engineer's point of view, and consists in cemented watertight drifts from the surface to well within the pyritic zone of the seams. Vertical shafts should similarly be made watertight. Furthermore, when working a seam the workings should not extend upwards beyond 15 to 20 ft. from the beginning of the pyritic zone. This remedy, if applied, while not yielding perfectly dry mines, would certainly stop surface waters from penetrating the mine workings and would avoid the installation of emergency pumping plants of undue size. Unfortunately most of the mines of that basin were started by owners with limited means, who did not look to the future, but started working a seam as soon as it was struck. A real case of "après moi le déluge."

Boiler House.—The steam producing plant consists of 5 Lancashire boilers of about 1,000 sq. ft. heating surface each. The heating was effected through forehearths, furnaces built in front of each boiler, and certainly the most wasteful coal eaters imaginable. The fire-bars were of undulated shape in order to increase air admission. The doors, however, were of wrought iron, warped and gaping at top and bottom. The heat within the furnace was so great that the firebrick arch above them was fused and never lasted more than two months, sometimes not more than a fortnight. The top of the furnaces frequently was red hot, so that the heat in the boiler house was unbearable. The pipes which connected the gauges with the boiler passed through the masonry of the furnace and gave constant trouble. The extremely hot flames on entering the two heating tubes of the boiler found a check on the slightly protruding lips of the inner tube where it is riveted to the openings in the boiler end, and these, although protected by firebricks which were fused within a week of starting a furnace, were so seriously corroded by the hot gases that leaks in those joints were of constant occurrence. Of the five boilers two were always out of action. They had to be freed from heavy scale, leakages on the riveted parts had to be attended to, and the arch over the furnace had to be rebuilt.

* A simple way to overcome a lot of trouble connected with the very long pipe lines consists in replacing them by a vertical bore-hole.

† The coal seams of the region are all well known and most carefully recorded on the geological map of Loutongine. These records are not as a rule sufficiently made use of.

To keep steam up the best round coal was required, about 35 tons of which was consumed in 24 hours.

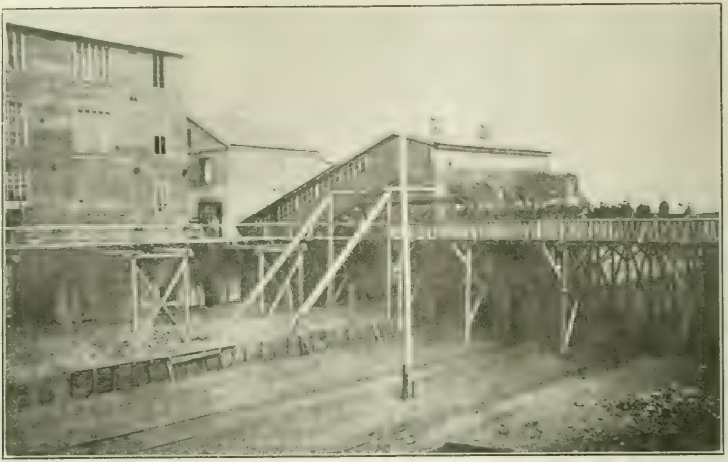
Apart from the deficient furnaces the feed water was suspected as the main cause of boiler trouble. Chemical analysis confirmed this, and showed the water to contain so much ferric and other sulphates that the corrosive action on the boiler plates and joints as well as the troublesome incrustations were fully explained; it remained, however, a mystery that this feed water, the mine water, had been in use for some fifteen years and no attempt had been made to replace it when the new power plant was installed.

The water of a small creek running through the property was found after analysis to be of excellent quality and was therefore selected as a substitute for the mine water. This necessitated the erection of a small pumping plant, the laying of a pipe-line 500 yards long, the cleaning out of the old sump, the establishing of a temporary sump, and the reorganization of the various feeding pumps with their pipe-lines, an easy task in peace times but rendered extremely difficult through war conditions, as supplies such as pumps, pipes, electric cables, etc., were almost unprocurable. The installation for the new feed-water supply was completed in April, 1915, and from that moment all boiler troubles disappeared.

With the change of feed water the furnaces also were being altered. In the type adopted the fuel is burnt within the tubes. The grate consists of perforated cast-iron slabs 6 in. square which, chessboard-like, are loosely held in position on a skeleton frame which rests on the sides of the tubes. The frame's inner end is fixed to a semicircular plate which shuts off the ash pit from the rest of the tube, while the part projecting above the grate level is utilized to hold in position a row of firebricks which constitute the fire bridge. The cast-iron door of the furnace is fastened to the outer end of the frame and to the projection of the inner tube. The space below the door is closed with a sheet-iron flap provided with two holes into which are fixed short trumpet-shaped 3 in. tubes; into their centre plays a steam jet, thus blowing air into the space below the grate and through the holes of the cast-iron plates through the burning coal. Most of the ash with the clinkers collect on top of the plates and are periodically scraped out. A broken cast-iron plate can be removed and replaced without drawing the fire. The furnaces, which had been seen in satisfactory use at neighbouring collieries, proved very economical. The total coal consumption was reduced to 16 tons of coal per 24 hours with 4 boilers going, and the coal used was roughly screened slack. Taking into consideration the monetary value of the round coal formerly required as against this slack, the daily economy amounted to roughly £50.

Another illustration of the use of bad feed water was afforded through the inspection of the tubular boiler of a portable Marshall engine. The tubes were coated with a layer $\frac{1}{4}$ in. thick of reddish scale, out of which protruded innumerable crystals of gypsum. To remove the scale an elementary chemical process was applied by allowing the water of condensation which resulted from the heating of the mechanical workshop to flow through the boiler for a period of about one month, after which time all incrustations had been completely removed. The water of condensation, really distilled water, had dissolved the gypsum, which was the caking material. The other ingredients of the scale, chiefly consisting of iron oxide, were found as a loose powder at the bottom of the boiler and were easily sluiced out.

WINDING ENGINES. — The winding engines actuating the endless rope haulage in shafts 1, 3, and 5 were similar in design but used different sized ropes, No. 1, 1 in., No. 3, $1\frac{1}{8}$ in., and No. 5, $\frac{7}{8}$ in. These were all standardized to 1 in. steel ropes. The incline shafts, varying from 300 to 380 fathoms in length, necessitated ropes of from 1,400 to 1,700 yards. When war broke out these steel ropes could be bought at £2. 16s. per cwt., which price rose to £18. 15s. per cwt. in June, 1915, and were hardly procurable even at that exorbitant price. The wear of the ropes was appalling, and the numerous breakdowns of the hauling engines pointed to their weak or faulty design. Each of the winding engines consisted in its main part of a drum with wooden (oak) facings and two return pulleys. The rope coming from the shaft went over half the circumference of the winding drum, then on to a return pulley back to the winding drum, to return to the second return pulley, and again for a half turn over the winding drum, on to two direction pulleys and down the shaft. The rope coming from the shaft with its full load of tubs on its first wind on the drum has a greater wearing effect on the wooden facings than the subsequent winds: it eats more rapidly into the facings than these. The first diameter of contact after a short use of the winder is therefore smaller than the subsequent ones, and consequently the length



SCREEN HOUSE AT NO. 3 SHAFT.

of rope of the first wind is insufficient to meet the length required for the second or third wind. That difference in length, which becomes greater the longer the winder is in use, must be compensated for from somewhere, and leads to either the displacement of the return pulley's shaft bearings or those of the winding drum's shaft, or causes them to run hot, or to the stretching of the rope, or to the breakages of shafts, pulleys, or bedplates.* All these mishaps occurred until the cause thereof was definitely ascertained. The remedy was as usual very simple once the cause had been ascertained, and consisted in keeping the depth of the second and third grooves of a slightly deeper cut into the drum's wood facing than that of the first groove. This was effected through the use of a special tool consisting of a blunt feeler in line with the first groove. This feeler was rigidly fixed at right angles to a horizontal bar, the latter being parallel to the drum's shaft. Two cutting tools were clamped to that bar in line with the second and third groove. The bar could be fed towards the drum. When doing so the cutters engaging the second and third grooves deepened them, and the feed motion was stopped when the feeler touched the bottom of the first groove.

Another mistake in the design of the winders consisted in having the return pulleys on a horizontal shaft. The latter should of course be so inclined that the return pulley's groove in its lowest part should be in line with the first groove on the winding drum, while the groove in its upper part should be in line with the second groove on the winding drum.

None of the mishaps above-mentioned recurred after the alterations mentioned had been effected.

LABOUR CONDITIONS, which under normal conditions present certain difficulties owing to the necessity of providing 80% of the workmen from outlying districts, were rendered particularly difficult through the constant interference of the local police. Coal mining had been declared to be of vital necessity to the country shortly after the outbreak of the war. The local police held that this applied to men working underground only, with the result that one day they called up all stable hands, another day screen hands, then again firemen or electricians. This meant that their ruling had to be appealed against, and if an answer to the appeal was slightly delayed the men were sent to their respective military units. Once in the army they could not be got back. Then again they called up all the lads of 18, as they had to be militarily trained, and whatever was tried they would not enter into the spirit of the ruling referring to coal mining. The general output from all the coal mines necessarily decreased, and by the

* [illegible]

time the petty police interferences were stopped adequate labour could not be procured anywhere. The Minister of Mines temporarily rescinded the regulation prohibiting female labour underground. This measure did not materially assist. A limited number of prisoners of war were procurable in the early part of 1915, and proved useful stop-gaps to keep the mines going. The first consignment of prisoners of war, Austrians, consisted of 100 men. They had to be credited at the same rate of pay as Russian workmen. One-quarter of their earnings was retained by the Russian State, and out of the three-quarters remaining they had to pay for their food and clothing. The latter, which included a sheepskin coat and boots, while being refunded in small instalments constituted a serious initial cash outlay to the employer of prisoner of war labour, roughly 100 roubles per man. A proposition to import Chinese labour was very much discussed by the local Chamber of Mines, but never matured as regards the Donetz coal mines. Chinamen were, however, largely imported as mine labourers into Siberia and the Ural Mountains. Apart from police interference, the inadequacy of railway management and scarcity of rolling stock interfered with labour conditions. The mine required a daily consignment of 50 trucks to take away its output. The loading of the trucks was in the hands of small contracting parties of Tartars, who specialized in this work. The mine was many days without receiving any trucks at all, then perhaps two or three a day, rarely 20, with the result that the loaders could not make a living and left the mine. Loading had then to be done by screen girls or prisoners of war, and this interfered with their regular work. Occasionally during a Sunday or holiday the mine received as many as 100 trucks which had to be returned to the railway authorities within 24 hours of their receipt unless incurring penalties. To cope with such emergencies the prisoners of war had to be relied upon, as Russians would not work on those days. The irregularity, and particularly the deficiency in the supply of trucks, entailed an accumulation of stocks which amounted to over 60,000 tons in March, 1915, having a value of some £30,000. After the outbreak of hostilities the coal was sold on the cash-on-delivery system, so that coal in the yards meant a deficiency of cash at the bank. From November, 1914, until the end of March, 1915, the men could not be paid regular wages. Bread, meat, tea, sugar, and some wearing apparel they could obtain at the mine store, purchases being entered in their books, and small weekly cash allowances enabled them to purchase other requirements in the neighbouring villages. This hand-to-mouth existence was the cause of much unrest and led to several minor strikes, which were all settled amicably on fully explaining prevailing conditions. In what other country would it have been possible to carry on without paying the workmen for five months? Relief was obtained when, after much parleying with Ministers, one of the Government Railway Administrations assented to take over all stocks. They paid £10,000 on account, with which the most pressing liabilities could be discharged. Railway trucks were re-

THE [illegible]

ceived more regularly thereafter and work again proceeded smoothly.

The character of the Russian workmen during the period of great tension could be studied thoroughly, and proved to be more like that of obedient children than of grown-ups. The men were easily led, amenable to reason, and appreciative of any teaching and betterment in living conditions. Bullying they resented, but punishment for real neglect of duty was taken as a matter of course.

HOUSING AND SANITATION.—Ever since the first start of the mines, the housing of men and staff lagged behind requirements. With the mines working at their full capacity, two men had to share one bunk, so that when the day-shift men worked the night-shift men occupied the bunks, and vice versa. While some of the married men of the artisan class were assigned to self-contained lodgings consisting of one or two rooms, ante-room and outhouse with summer kitchen, others had to be lodged in curtained cubicles within a large room. These cubicles were not in favour, and the families assigned to them preferred to have a dug-out or make-shift structure of their own, however insanitary or primitive these might be.

The housing question received a necessary and salutary fillip through an order of the Tsar issued shortly after war broke out. The order dealt with the sanitation of the army and civil population; its execution was entrusted to the Grand Duke of Oldenburg, who for that purpose was invested with extraordinary powers. This order was necessary to prevent the spreading of infectious diseases, particularly cholera, through the country, sorely deficient in the most elementary sanitary dispositions. A host of inspectors, all with army rank ranging from generals to corporals, were sent to all parts, and the lower the rank the more officious the individual. We at the coal mine were under the supervision of a district inspector, a surgeon general, who was assisted by a lieutenant doctor just graduated in Paris. Both these gentlemen took their positions seriously and endeavoured to administer the real spirit of the general order. They worked in harmony with both the resident doctor and the general management. Not so their special local representative, a first-aid man with sergeant's rank, in Russian called a "feltsher." This individual was out for loot and good living. He endeavoured to find fault with everything, and threatened with punishments such as huge fines or imprisonment whenever his personal whims were not complied with. This interference was a real nuisance; to put a stop to it he was offered a private salary of 100 Rs. (£10) per month so that he might report to the management any infringements against sanitary regulations before taking official action. This premium, which he gladly accepted, had the desired effect. His visits to the mines were restricted to the first of each month, when he received the special salary, and infringements were not heard of any more. This was the usual method adopted with Government officials, and dates back to the times of Catherine II. the Great (1762-1795).

The work which was carried out as the result of the Sanitary Commission's existence was manifold, eminently useful, and may be summarized as follows:

(1) All the wretched lodgings, the dug-outs, which in some cases were more like cellars, had to be destroyed and the occupants to be content with curtained cubicles. The roofing in these dug-outs generally consisted of a layer of clay resting on rough boards and covered with turf. This covering, while affording protection against snow and frost, is damp in wet weather and therefore most unhealthy. In one of these lodgings the family, consisting of parents and five children, shared their room with a goat, several pigs, hens, geese, and turkeys.

(2) Damp walls, chiefly due to porous, insufficiently baked bricks were remedied by an external application of thin cement; defective mortar joints in stone buildings were similarly remedied; while in the case of buildings consisting of mud bricks, clay covered, and particularly panel buildings with mud fillings, the walls were protected from rain by a covering of boards or shingle.

(3) Roofing consisting of black sheet iron, although painted, proved a constant source of trouble, particularly near the boiler house, where iron sheets were eaten through by sulphur fumes in from 2 to 3 years. The iron roofings were therefore gradually replaced by shingle roofing, which has a life of at least 25 years, and which when painted with aluminium sulphate and silicate of soda is sufficiently fire-resisting not to entail an extra premium for fire insurance. The iron roofing of the power house and the turf roofing of the dynamite store were replaced by "Eternit" weather-resisting light slabs, consisting of a mixture of cement and asbestos. Tiles or slates, besides being difficult to obtain, were not applicable on account of their great weight, which would have necessitated strengthening and in many cases replacing the whole of the wooden framework.

(4) The water supply for domestic purposes, which had been installed several years ago and supplied some of the buildings near No. 1 and No. 3 shafts, proved to be of good quality both chemically and bacteriologically. This supply was perfected by installing storage tanks, and was extended to No. 5 shaft on account of the well water then in use in that locality having been proved by analysis to be unfit for human consumption. Most of the barracks were provided with washing accommodation for the men, consisting of wide galvanized iron troughs with small overhead showers. These simple installations were highly appreciated by the men and immensely pleased the Sanitary Commission.

(5) Vermin, particularly bed bugs and body lice, both carriers of infectious diseases, had to be exterminated. The former were satisfactorily dealt with by burning sulphur in

portable specially designed sheet-iron stoves, which consumed the sulphur very rapidly and produced sulphur dioxide so quickly that the insects trying to escape into the ceiling or loft for breathing space were overtaken in their flight by the fumes. Six stoves were generally required in one barrack for a thorough fumigation, and the sulphur charges were calculated to yield a 3% atmosphere of SO_2.

Body lice were exterminated by the use of medicated soap, and during the work people's presence in the bath house their clothing was subjected to a temperature of 100° to 110°C. in a cubicle 8 ft. long, 6 ft. high, and 2 ft. 6 in. wide provided with sheet-iron doors and asbestos insertions, heat to the cubicle being supplied by a nest of cast iron pipes, these being the flue of a small anthracite stove. Steam heating with superheated steam of 130°, which was tried first, did not produce the temperature required.

The water-closets throughout Russia are of absurd construction, and those existing at the mine were no exception to the general practice in that country. To obtain thorough disinfection a daily use of chloride of lime was resorted to, and the inmates of any barrack were collectively held responsible for the cleanliness of this necessary outhouse. Detailed plans for new constructions were submitted to the Sanitary Commission and approved of by them. The execution of the buildings had, however, to be deferred on account of scarcity of cement and building sand, so that the scheme remained one of good intentions but quite appreciated by the Commission. Similarly underground appliances for the same purpose never got beyond the model stage.

With dealing with officials wrapped in red tape both plans and models are generally most useful adjuncts to tide back the official wrath.

FROTH FLOTATION

By V. F. STANLEY LOW,

Member of the Institution of Mining and Metallurgy, Member of the Australasian Institute of Mining Engineers, Member of the American Institute of Mining Engineers.

The author, an Australian engineer, was connected with Broken Hill for a number of years, being manager of Block 10 mine from 1902 to 1910. Reference is made to this article in the Editorial pages.

ALTHOUGH the concentration of minerals by means of froth flotation, as distinct from the Elmore vacuum process, has been in successful commercial operation for over fourteen years, very little has been written on the subject by British metallurgists in the British technical press. This is in part due to a national characteristic by virtue of which our metallurgists and engineers are content to carry on the work in hand, seeking no notoriety but satisfied if their efforts meet with success. There may also be in their minds a tinge of fear that, should they commit themselves to technical articles in the press, their co-workers may suspect them of an assumption of superior knowledge to which they in no way wish to lay claim. But, unfortunately, the greatest cause for silence would appear to be the refusal by directors of mining companies and of companies holding patent rights to allow their officers to publicly communicate the results of their researches in the laboratory or mill. The consequence has been that anyone who has wished to gain information, for instance on the flotation process, has been mostly dependent upon literature of American origin, although the process did not come into prominence in America for several years after it had been in successful daily operation on a large scale in Australia. As so little has heretofore been written, the writer offers his apologies for including in the following article a great deal of what may appear to be of an elementary character.

As modern flotation—again excluding the Elmore process—had its birth in Melbourne, and was brought to maturity in Broken Hill, Australia, a short description of the Broken Hill deposit will be of interest. Broken Hill is now mined by ten companies, distributed over its short length of approximately three miles. The lodes have varied in width from a few feet, in some cases, up to over four hundred feet in Block 11. In Block 10 the ore-body has been followed down to the 1,815 ft. level. The Broken Hill leases were first pegged out in 1883, but it was not until 1885 that the first company, the Broken Hill Proprietary, was floated and mining operations were taken in hand. For some years metallurgical operations were confined to the direct smelting of ore won from the oxidized zone.

But, as the carbonate began to give place to sulphides, so it became necessary to concentrate the latter before smelting. Thus, water-concentration plants consisting of crushers, jigs, tables, vanners, etc., were erected. These plants produced a galena concentrate that carried also silver and a little zinc. The by-products consisted of slime, middling, and tail. The middling generally carried a fairly high percentage of zinc—in some cases up to 22%—and the tail also carried zinc, but in lower proportion. It was not possible to concentrate the blende from the middling and tail by the ordinary methods, as there was not sufficient difference between the specific gravities of the mineral and the gangue to allow of a clean separation by such means. The slime values in most cases closely approximated those of the crude ore. A great deal of the material was undoubtedly amenable to further vanner concentration had it paid to carry out such work. But in a district where labour, fuel, water, and stores were all expensive it was not economically advisable to chase metal values too far. The Proprietary Company, which did its own smelting, made use of a portion of its slime by sintering or heap roasting in the outskirts of Broken Hill, and then despatching the sinter by rail to the smelters. With several mills in the district in active operation, large dumps of material steadily grew, until by the end of 1902 there were many millions of tons of zinciferous tailing lying on the surface awaiting the advent of some suitable method of treatment. In 1905 the Zinc Corporation purchased 4,000,000 tons of middling, tailing, and slime from certain of the mining companies, with a view to converting the contained mineral wealth into commercial value.

Although the several companies are distributed over so short a length of lode, there are great differences in the nature of the ore; so much so that what may be an ideal system of flotation for a mine situated in the centre of the group may not be at all suitable for use on a mine at either extremity. Even within an individual mine remarkably sudden changes were sometimes observed. For instance, in Block 10 it was no uncommon occurrence to find soft friable ore suddenly giving place to the hardest rhodonite material, which in most cases carried high values in silver, lead, and zinc, although this occasionally gave place to an almost barren rhodonite that did not pay for removal. The varying amount of calcite carried by the ores of the various mines has necessarily had considerable bearing on the type of flotation installed; and, when it is taken into consideration that the flotation process was brought into being and that it passed through various stages and vicissitudes to almost complete success in this district, it is not surprising to find that the several companies have been anything but uniform in their choice of a flotative system for the treatment of their zinc tailing.

Prior to the arrival of flotation, a company of German origin erected a dry magnetic plant in Broken Hill, and successfully treated a parcel of middling purchased from the Block 10 company. When this parcel of purchased material had been passed through the magnetic machines the plant was closed down, probably because the costs of purchase, transport, and treatment did not allow of a sufficient margin of profit on the grade of concentrate producible by the process. This was followed by the construction in 1901 of a dry magnetic plant by the Sulphide Corporation on the Central mine. But the other companies did not adopt the process, either because it was considered that the magnetic treatment of their material did not offer a sufficient margin of profit, or, as was the case with the Block 10 company, it was feared that the presence of minute particles of lead carbonate in the material to be treated might result in the contraction of plumbism by the men engaged in any form of dry concentration.

The magnetic plant, consisting of five Mechernich machines, erected by the Sulphide Corporation in 1901, was supplemented in 1904 by a further plant of 22 similar machines. These plants ran until 1907, when they were closed down after having treated an aggregate of 342,000 tons of dump middling.

Although the extensive litigation which has taken place with regard to patent rights has brought to light that flotation patents were granted to Haynes (1860), Everson (1885), Hezekiah Bradford (1886), and others, it was not until after the advent of Potter in 1902 that froth-flotation was turned to metallurgical account. Potter's patent set forth that for the treatment of ores containing lead, zinc, copper, iron, and silver in combination with sulphur the finely pulverized ore is placed in a vat provided with stirrers, acidulated solution is added, the whole is well stirred, and heat applied; the addition of heat causes the mineral to rise; the mineral froth is to be allowed to flow automatically and continuously into another vessel or to be skimmed off. The patent calls for the addition of 1 to 10% of any acid.

In 1902 when I was in Melbourne on my

way to assume the general management of the Block 10 company, I was jokingly told that a man named Potter was going to revolutionize Broken Hill treatment and to concentrate all the metals from the dumps, which had, so far, defied all other experimentalists. I made a visit to Potter's agent, where it was clearly demonstrated that if finely ground Broken Hill dump material was placed in a small beaker, a weak solution of sulphuric acid poured in, and the beaker placed over a flame, a considerable portion of the mineral contents would rise to the surface and could be skimmed off. While the demonstration was in progress, the patentee stated that all one had to do to treat ore on a large scale was to cut in half a 400 gallon iron tank, that is, a tank about 4 by 4 by 4 feet, put in the crushed ore, light a fire under the tank, and scrape off the float as it rose to the surface. Such instructions for the practical working of the process did not greatly appeal to me, but I was nevertheless greatly impressed with the possibilities of the process, and decided to give it due trial as quickly as the new duties soon to be undertaken would allow. Experimental work was afterward taken in hand at Block 10. The preliminary beaker tests were verified, but with work on a larger scale it was observed that only part of the blende rose to the surface and remained there. Portions of the blende rose to the surface and fell back, portions rose only part way to the surface and fell back to the bottom, and portions as far as could be observed did not rise at all. In all these experiments the material to be treated was dried, ground to pass through 40 mesh, weighed, and submitted to a solution of sulphuric acid in water. This water was taken either from the purified supply of the laboratory, or was drawn from the town mains. The result was generally a partial and unpayable float. Looking back on this experimental work, it is probable that if the test material had been ground wet, instead of dry, and mine water, instead of pure water, had been used for making the acid solution, more hopeful results might have been obtained. Several different forms of flotation vessels were tried, some of which gave better froth than others; but the final results were always unsatisfactory. In the meantime, such excellent results were being secured by the Delprat process at the Proprietary mine that experimental work on the process as outlined by Potter was discontinued.

The Block 14 company in 1903 constructed a plant for the utilization of the Potter patent. In this plant scrapers on an endless chain were used for removing the treated material up an inclined plane from the hot solution in the flotation machine; but, although the moving parts were made of gun-metal, many mechanical defects made themselves evident, and the plant was closed down after running unsuccessfully for a short period.

In November, 1902, Delprat applied for a patent for his "salt-cake" process. In this process nitre-cake (sodium bi-sulphate) was added to the water as a flotative agent, in place of plain sulphuric acid, as in the Potter process. The same difficulty in obtaining a suitable separating vessel confronted the metallurgists of the Proprietary company for use with the Delprat solution as had been found by other metallurgists for use with the Potter solution; and it was not until about the middle of the following year that the first parcel of floated zinc concentrate was awaiting despatch at the Proprietary mine. At the end of 1904 the Delprat plant on the Proprietary mine was treating 500 tons of material daily; and at the end of 1905 the feed had been increased to 1,000 tons daily. Sulphuric acid was eventually used in place of nitre-cake. The flotation vessels used at the Proprietary plant were 9 by 9 ft. at the top, 15 ft. deep, and 2 by 1 ft. at the bottom. The solution was fed into the vessel at a temperature of 200°F, through two pipes perforated at the ends and extending almost to the bottom of the vessel. By a suitable arrangement of baffles, matters were so arranged that the solution from the rear pipe washed the feed forward, where it met the stream from the front pipe, and there received its final treatment before the blende rose to the surface as a froth and overflowed. There was a continuous flow of tailing through a spigot in the bottom of the vessel, just below the forward solution pipe. A baffle in front of the feed delivery, and two baffles within the vessel, lessened the amount of gangue, which would otherwise have risen with the concentrate, and consequently have lowered its grade.

This process is not effective in the presence of more than 3% of fine slime, for any excess above this quantity gives a low concentrate. But to ensure efficient work, the material should be ground so that 70 to 80% will pass through 60 mesh. The generally accepted values of the work done at this plant were as follows:

	Silver oz	Lead %	Zinc
Crude material	5·5	3·25	14
Concentrate	12·0	6·00	47
Tail	3·0	2·00	2

For the main part, the gangue consisted of rhodonite and quartz, with a small percentage of calcite and fluor-spar. The amount of calcite, 3%, present made the material an ideal one for this system of flotation. The acidity was maintained at 1%, and to do this 26 lb. of sulphuric acid was required p-r ton of material treated. Each vessel was made of cast iron, lined near the bottom with hard wood as a protection against the abrasive action of the feed particles, and was capable of treating 15 to 20 tons of material per hour.

In the days prior to flotation, the dumps of the Central mine belonging to the Sulphide Corporation, and of the Block 10 mine were the richest in zinc and silver contents; and the former company may justly claim to have more consistently tackled the problem of blende concentration than any other company in the district.

As has already been stated, the Sulphide Corporation was already producing a blende concentrate by means of the dry magnetic process in 1901. In 1904 this company erected a pilot plant for treating dump material by the Cattermole, or granulation, process, which was succeeded by a plant capable of treating 100 tons daily by this process in 1905. It is interesting to follow the operation of the latter, as the process in use gradually merged from granulation to froth flotation. The general outline of the granulation process was thus: the agitation of the material to be concentrated was effected with oil, water, acid, or alkali, and an emulsifying agent, such as soap, so as to collect the mineral particles into granules or agglomerations. After passing through this agitation, the mixture was delivered to an inverted cone, where it was met by an upward current of liquor, the province of which was to remove and overflow the lighter particles that had not been affected by the reagents in the mixer. After the lighter particles had thus been removed, the pulp was delivered to another mixer, and thence to a second upcast separator, where coarser particles of gangue were removed. This separation produced a certain amount of concentrate, but a considerable portion of the granulated material passed out with the coarse sand, so the whole overflow was sent to a third mixer, and thence to a reciprocating table, where it was supposed that the granules would float on the surface and leave the table on the lower side opposite the feed, and that the worthless material would be delivered over the end of the table. In practice it was found that a considerable proportion of the granulated particles lay on the bottom of the table, and did not rise to the surface as had been expected of them; but this was overcome by arranging a perforated pipe lengthwise along the table and blowing air on to the pulp. The blowing had the desired effect in causing the granules to float and gave a satisfactory delivery of tailing over the end of the table.

When the 100 ton plant was in operation on the above lines it was soon found that the presence of slime lowered the value of the concentrate, and that very close attention was required to produce good final results from the table. Choking of the upcast pipe was also of frequent occurrence. Further experience showed that the agitation as arranged was excessive; therefore, the third series of mixers was deleted, and then the second, so that in the end only the first series of mixers was left in use. All the concentrate, instead of only part, was floated and the upcast in the separators was cut out. At the end of 1905 the plant had been completely changed from the granulation to the flotation process, and consisted of only one series of six mixers, from which the material was allowed to drop freely into an inverted cone separator, where the concentrate floated off, and the unfloated material was allowed to drop freely through a spigot in the bottom of the cone to another cone separator below. A similar aerating effect to this free dropping of the pulp could be obtained by placing an elevator between the two separating cones.

The reagents employed were up to 1% sulphuric acid and up to 2% oleic acid per ton of material treated. This mill was closed after having treated 136,000 tons of material, and was succeeded by a flotation plant attached to the lead-mill for treating current output.

The Minerals Separation company purchased from the Sulphide Corporation a parcel of dump material, and erected a plant on the Central mine for its treatment. This plant successfully treated over 700,000 tons of material before it was closed down in 1911. In 1907 the Sulphide Corporation erected a flotation plant for the treatment of dump slime. This plant produced a zinc concentrate so high in lead and, consequently, so low in zinc that there was not a ready market for the product. The plant was closed in 1909, and was eventually modified for preferential flotation; it will be referred to again later. In 1907 the flotation process, in place of being used only on dumped material at the Central mine, became an integral part of the main lead mill, and has so continued, with various modifications, up to the present date.

In 1905 the Zinc Corporation was formed and purchased four million tons of tailing from several of the mining companies. A plant was erected on the leases of the British Broken Hill Proprietary company, where it is stated that both the Potter and the Minerals Separation processes were given unsuccessful trial. In 1908 the erection of a plant containing sixteen units of the Elmore vacuum machine was completed. The vacuum process was here kept in operation until 1910, when a change was made to the Minerals Separation system. As the blende concentrate from the Elmore machines carried a considerable quantity of galena, for which very little payment was received, and the presence of which necessarily made the percentage of zinc lower, it was deemed advisable to submit the concentrate to treatment on tables; but as the oil used in the vacuum process rendered the material unsuitable for treatment in the condition in which it left the Elmore plant, it became necessary to dry off the oil and re-pulp with water before tabling. The drying added to the cost of production, and the oil fumes from the dryers caused considerable annoyance to the residents of the district; but the extra cost of production was more than offset by the formation of a galena concentrate in marketable form and a blende concentrate considerably higher in zinc.

The Elmore vacuum machine is too well known to require description here, nor can it be sufficiently regarded as a froth-flotation machine to come within the province of this article. As in the early days of the Delprat process, prior to the introduction of mechanical feed into the operation, I became so impressed by the rough and ready manner in which the dump material was heaved in irregular quantities at irregular intervals into the frothing vessel that I began to believe that at last in so insensitive a machine a panacea had been found for all the ills of recalcitrant blende, so in viewing the Elmore unit I became lost in admiration for the ingenuity displayed and the mechanical knowledge used in overcoming the numerous difficulties which had been encountered in the perfecting of the vacuum system. Although the Elmore plants which had been erected by the British and Block 10 companies and the Zinc Corporation have now passed out of use, they in their time greatly assisted in the solution of the blende production problem at Broken Hill.

In 1905 a company was formed for exploiting the De Bavay process. Tailings were purchased from the mining companies, and a plant was erected at the northern end of Broken Hill. In the De Bavay process the surface tension of the liquid employed is utilized by bringing a thin stream of pulp on to the surface of this liquid in a suitably designed vessel. The blende floats on top of the liquid and is delivered over the lip of the vessel into suitable launders, while the gangue and such of the material as is carried with it falls to the bottom of the vessel, and is delivered through a spigot to a similar vessel below, where the process is repeated, and so on, until a clean tailing has been produced. As the process is not at all suitable for the treatment of slime, great care is exercised in its elimination so that only clean grit may be submitted to the process. This grit, which has been crushed to pass through 40 mesh, is mixed with acid solution and churned up in an A—Z agitator. After a lengthened period of agitation the material is allowed to partly settle, a considerable amount of liquor is drawn off, and two washings with clear water are given to remove the acid. The pulp is then removed to another agitator, where a definite proportion of oil is added and agitation takes place. After this agitation the pulp is elevated to a cistern in the roof from which it flows to the top vessel of each series and thence downwards as already described. For a long time the De Bavay process provided by far the highest grade blende concentrate in the district. Its disadvantages are that the plant covers a disproportionately large area per ton of material treated, and this, in turn, leads to added expense in supervision, operation, and plant construction; the process is also a delicate one and requires careful supervision. At a time when other plants had to be content with turning out a concentrate containing 43% zinc and less, the De Bavay machine was giving an output of blende concentrate assaying as high as 47 and 48% of zinc. The De Bavay process and plant has recently been abandoned, and the North and South tailings are to be treated by the Minerals Separation method.

From what has been written it will be seen that neither the De Bavay nor the Delprat process was suitable for treating slime. The Minerals Separation process, although capable of treating current output including slime, had not been successful in producing a readily saleable concentrate from the partly oxidized dump slime. In 1908, Horwood introduced a process for dealing with such material. He first roasted at 400° C, so as to sulphatize part of the galena, and then submitted the roasted material to the Minerals Separation process, with pulp at 130° F, when the blende, which had remained unaltered in the roasting furnace, gave an excellent float and the sulphatized lead remained behind. A blende concentrate as high as 50% zinc has been obtainable by the Horwood process on the Broken Hill ores. The galena concentrate recovered in this process is not, however, of a very high grade. A pilot plant was in the first place erected at the School of Mines, Bendigo, and the process was adopted by the Zinc Corporation, which put up a 70 ton per day plant for treating dump slime. In roasting material containing blende, pyrite, galena, &c., the furnace temperature may be raised as high as 500° C. Little or no oxidation of the galena will take place when the pyrite is burning, and the higher temperature does not alter the blende. A good clean resinous blende will withstand a higher temperature than a blende containing iron. The process has been markedly successful in treating the complex ores of the Rosebery district, Tasmania, which had hitherto defied successful metallurgical treatment. The intermixture of the blende, pyrite, and galena was so intimate that many metallurgists considered the ore to be a chemical compound, rather than a mechanical mixture, of lead, zinc, copper, iron, sulphur, &c., and that any other than chemical separation would be impossible. However, after crushing and treating the ore, the Horwood process successfully produced a high-grade blende concentrate —up to 57% zinc—and a galena residue carrying some 20% lead. The objections to the process are that roasting is costly, consumption of acid is heavy, the galena concentrate is not high in lead, and the concentrates are very fine for smelting; but this last objection obtains with all slime concentrates.

Up to the beginning of the war, nearly all the blende concentrate was sold to German buyers on a purchase formula somewhat as follows:

$$[illegible]\ \tfrac{1}{2}B\,(Ag-5)+(Pb-8)-R$$

where

A is average price of zinc over 6 months from time of delivery, in shillings

B ,, ,, ,, silver ,, ,, ,,

Zn is the assay-value of the zinc contained in the concentrate

Pb ,, ,, ,, ,, lead ,, ,,

Ag ,, ,, ,, ,, silver ,,

R is the returning charge.

From the above formula it will be seen that only 95% of the price of zinc per ton was allowed after the deduction of 5% from the zinc assay-value, only half the price per ounce of silver was allowed after deducting 5 ounces, and only one shilling per unit was allowed for the lead after deducting 8% from the assay-value. In other words the German buyer took for himself, free of charge, from every ton of concentrate 5 units of zinc, 5 ounces of silver, and 8 units of lead; and, after accepting this gift, he gave only 95% of the market price of zinc, only half the market price of silver, and only one shilling per unit of lead; he then deducted from the total payment per ton, calculated on this basis, his returning or smelting charge which he varied from time to time to suit his own convenience. This charge was seldom, if ever, below five pounds (£5) per ton.

In the earlier days of blende production, when protests were made with regard to this lead robbery, sellers were told by the German buyers that the presence of lead in a blende concentrate was most objectionable. The producers therefore turned their minds to the elimination of as much of the lead from the concentrate as possible. This removal of lead would result in the production of a saleable lead concentrate, a blende concentrate considerably higher in zinc, and would lessen the unwilling gift of lead to Germany. The elimination of lead was first effected by tabling the blende concentrate and subsequently by preferential flotation; but as soon as the new grade concentrate, higher in zinc and lower in lead, was in being protests were immediately made by the aforesaid buyers, who stated that at least 5% of lead in a blende concentrate was necessary; and later contracts embodied a fine on the seller of 1s. 3d. for every unit of lead under 5%. Subsequent contracts were modified in this respect, but not to any great extent.

Apart from the question of leaden gifts to Germany, consideration will show that a blende high in zinc is a much more profitable proposition than one carrying only a moderate amount, provided, of course, that the cost of the higher production is not excessive. If, for instance, a blende carrying 40% zinc and 10% lead could be cheaply converted into a blende concentrate containing 46% zinc and 6% lead, and a galena concentrate containing, say, 55% lead and 14% zinc, the seller would be able to dispose of the two products at a much greater profit to himself than that obtainable from the original product.

(*To be continued*).

FOUR YEARS AS A PRISONER OF WAR

By J. C. FARRANT

(continued from the March issue, page 147).

The author, a well known mining engineer, continues his account of the treatment of prisoners at Doberitz.

March, 1915. Food parcels and tobacco were arriving fairly regularly, and every one was more or less settling down to gefang life. Rounders was the principal pastime, and inter-regimental matches were of daily occurrence, the teams being made up of N.C.O.'s (who were not compelled to work), men employed in lager, and those, a goodly few, who had "dodged the column."

On March 6, volunteers for farm work were called for. No Englishmen volunteered, but several hundred Russians signified their willingness. Later, however, parties were told off for kommandos, farming, factories, coal mines, etc.

The first batch of English from our block was warned off on April 2, and the Germans spent the day in rounding up men with good trousers, and forcing them to change with those men who were warned for kommando. As soon as this game was rumbled, the men who had presentable trousers spent the afternoon dodging the Germans.

The bread ration was now reduced to one-fifth of a 3 lb. loaf per man per day.

With the weeding out for kommandos, it became more difficult to "dodge the column," and as most of the work was of the pick and shovel kind we were very glad when Sunday came round.

New guards had replaced the old ones, and started to make themselves unpleasant. So a system was adopted of breaking them in. While at work one guard was in charge of ten men, and if a guard was a rotter, the men did as little work as possible, and caused as much trouble as they could by sliding off and joining up with other parties. Parties were frequently reported for insubordination, and doing no work, and were punished by standing to attention for two hours in the evening. If any man in particular was reported, he was tied up. The guards found out that it paid them better to let the men have a certain amount of their own way.

In the German barracks "Gott strafe England" was chalked up in many conspicuous places. It was also the head-line on their bread coupon cards. On one occasion toward the end of April, a party of 20 British prisoners of war were returning from work. They met a company of Germans, whose officer commanded our party to halt and face his company. When we were in position, and wondering what was coming next, he rode up to our party and shouted "Gott strafe England," these words being repeated by his whole company. Then with a look as if he had just stormed a position, he marched his company off, and German kultur scored another victory.

May 7. Captain A., second in command, gave orders to posterns to instil discipline into British prisoners of war with rifle butts, bayonets to be used if necessary. Printed notices to this effect were posted up in the barracks. In fact the death sentence appeared applicable to any crime from "pinching spuds" to "dodging the column."

May 12. Russian killed and ate a German N.C.O.'s white cat. He received three days' cells. The next morning, as the Russians filed on parade, our boys greeted them with cat-calls, causing a good deal of amusement. A German N.C.O., known as Tubby, rushed up to us demanding silence and the cause of the outburst. When he was told, "Militarismus" went by the way, and he was convulsed with mirth. (It was not his cat). This was the first occasion upon which I had heard a German laugh on parade.

May 13. Ascension day, and a holiday. Every man in camp paraded at 8 a.m. In the middle of the parade ground, facing us, two Russians were tied up with their hands above their heads. They had attempted to escape, but were recaptured, and this was the punishment, five hours daily. Both men were moaning. One of them fainted while we were still on parade, and the other man was only just conscious. Our men signified their disapproval by shouting at the Germans to untie them. While this uproar was going on, a Russian sergeant-major went up, and complained to a German N.C.O. on parade. The Russian was promptly kicked and ordered back to the ranks. He refused to go. Guards were called up, and he was arrested. The whole parade was then ordered to barracks, the order being accompanied by a couple of shots.

When we were inside, German interpreters came round saying, "The guards have orders to shoot on sight any man on parade or looking through windows." This was 11 o'clock in the morning, and indiscriminate firing was carried on till 4 p.m. Three Russians were killed and several wounded. Most of the huts in our block had bullet holes through them.

One poor devil of a Russian was in the latrine when parade was dismissed. He heard the shots and was afraid to come out. A German interpreter heard him and told him he would conduct him to his barrack. He had escorted him half-way when the Russian made a dive for his barrack and was shot and killed on the steps, the interpreter being powerless to stop the damned savages. This affair took place in view of our barrack. As the two guards who had done this noble deed disappeared from view, we opened a couple of windows, and looked out. A guard, who was standing on the road, let drive. Fortunately he missed. We didn't repeat the operation.

It was a very hot day, and all windows were closed. The rooms were about 20 ft. square. The men were lying down, as bullets were frequently coming through the huts. This is how we spent the first holiday in 1915.

May 24. Started cricket with a tennis ball.

May 27. Very hot; took load of stones to aviation grounds. Parcel and photos from home. Jolly good to get the tea.

May 28. Breakfast 5 a.m. Took stone to aviation grounds. Finished 3.30 p.m.; nothing to eat or drink since 5 a.m. Cricket in evening.

May 29. Carting stones to station. All wagons were pulled by the men. Guard got "dizzy." One piece of soap issued between four men. Last piece issued two months ago. Cricket in evening.

May 30. Sunday. Sand storms all day. Played cricket.

May 31. Working on sand-pit. Got ticked off for being late.

June 1. Another hell of a day. Breakfast 5 a.m. Four-mile walk. Carrying trees for four hours. Got back at two p.m. This is always considered a day's work. Had to turn out in afternoon, carrying iron bedsteads from station till 6 p.m.

June 2. Hot day; cleaning out deep ditch, stunk like blazes, working in water. Received splendid parcel. Sausages top hole.

Cricket in the evening was very popular, and Army and Navy matches created a great deal of interest, a couple of thousand men looking on. We used to get the shoe-mender to cover tennis balls with leather, making a very good ball. A hard ball was too dangerous under the confined conditions. We purchased some matting from Berlin as the parade ground was too sandy to permit of a good pitch.

The elevens representing the different regiments possessed some good talent, and the game was played strictly to rules. Many keen contests took place, promoting good fellowship through the camp.

June 11. I, with two or three others got a "cushy number" painting window frames for a church. The church was inside the German barracks, just across the road. A guard would take us over in the morning, and leave us in charge of the civilian contractor. Being a "civvy" we did not take much notice of him. On several occasions we went up to the organ loft and had a sleep.

July 5. Contractor wrote to camp authorities saying that we were most unsatisfactory, and spent most of our time in sleeping. We were taken up in front of the German in command of our block, who screamed and swore at us for about ten minutes. Germans love to shout.

July 11. Men employed in camp had a walk in the country. I was one of a fatigue party having to walk 6 miles out to the plains, where we were employed in shovelling sand.

July 19. Fifty more men were told off for our hut. It was very hot weather. It was impossible for every one to get in. Some slept on the ground outside, which was strictly against orders. This overcrowding lasted for about a week. We then removed into tents.

A few windows had been broken by cricket balls, and we were presented with a bill for £12. 10s. 0d. We complained to the kommandant, but with no result, other than if the money was not paid that night all sport would be stopped.

July 31. A jolly good job. A party of 50 was taken to an old canal. Our duty was to clear this of weeds, etc. There were two or three small rafts, and each raft party was given scoops with long handles. The rafts measured about 8 by 4 ft. We "quanted" up and down, manœuvring for position, each raft trying to capsize the other. Many spills occurred; I went in three times, and by the time we packed up there wasn't a dry man among the raft parties.

August 3. McDonald, of the R.N.D., killed. We had been to fetch sand from the plains, and coming back McDonald and another were on the pole of the first wagon. They came to a sharp dip. The heavy wagon got out of control. McDonald fell, and the wheel passed over him, killing him. There were no brakes on the wagon.

August 6. Scotty, another Britisher, shot. His mind became affected on May 13, when the shooting affair took place. He was taken to hospital, escaped from there, wandered to the lager, and tried to scale the barbed wire. The sentry killed him.

August 7. All privileges to British prisoners of war stopped. The reason given was the alleged brutal treatment by the British Government of the German civilians interned in England. This meant no sports, no cards, and all musical instruments were taken from us.

Life from now on was pretty miserable. Some more new guards made their appearance, and one in particular was a holy terror. He and another took ten men to Spandau, shovelling clinker; the party was split up into two parties of five, with a guard over each. Before the men started, he told them he had seen his own brother bayonetted on the west front by an Englishman. If ever a man hated Englishmen it was this fellow. He was over 6 ft. in height. If a man stopped working, he got a blow from the butt end from him.

The men used to return to camp with their hands blistered and bleeding. Complaints were made to the kommandant, so a different ten were sent daily. I went on that fatigue once. I shovelled coke with a coke shovel for eight hours, and didn't stop working once. I was all in when I finished, and by the time I got back to the lager at 8 p.m. I was just boiling over with resentment.

Chief Petty Officer A., senior N.C.O. of the R.N.D., was having tea with his mess, when I waltzed in, and after ridding myself of a few observations, I told him: "I'm damned if ever I will go again, and it's up to you as senior N.C.O. to see that no other man goes till things are altered." For it must be borne in mind that N.C.O.'s did not work, and many, though not all, were indifferent to the conditions under which the men worked.

August 17. A permanent fire brigade was formed, being made up of N.C.O.'s.

August 27. I got a "cushy number." Graf von Spee, brother of the late Admiral von Spee, built and presented a Roman Catholic Church to the German troops quartered in Döberitz. An artist from Berlin was engaged to paint angels and other figures. This artist required help, so he applied to our lager for artists. Cecil Tooke, of the R.N.D., was approached, but he wasn't keen, so his "mucking in oppo" asked me if I would go with him. I accepted. Four artists were required. The party consisted of Williams and myself, a Sheffield policeman, whose name I forget, and Jack Rudram, a North Sea fisherman. On the following morning we presented ourselves at the church, a guard taking us over. The artist had not arrived, but a German soldier, who was an artist by profession and also assisting, started us off on some panels. I had been daubing for about ten minutes, when some one touched my shoulder. I turned round and confronted a well-dressed German, who asked me in German what I was. I replied, "A prisoner of war." "I know that, but what are you in civilian life?" "An engineer." "Ach so! I knew you were no painter." It was the artist himself, and he informed me that my work was hardly up to the standard required. He then tried the others, who all shared the same fate. The artist then left for Berlin without saying anything to our guard, who was wandering round the church.

We all decided to come down on the following morning, and have another try, as it was much easier work than navvying. I told our guard that we were to return at 8 a.m. next day. Thinking this order had come from the artist he passed the instructions on to the Camp Bureau, so the following day found us again at the church. As soon as the artist arrived, being able to speak the 'bat,' I spun him a yarn, telling him if he put in a request for us we would bring down a 'pukka artist.' I told him further that we required no remuneration, and that there wasn't a job on earth we hadn't done. Being a bit of a sportsman he agreed, providing the artist we were to bring was all right.

The next day we took "Nobby" Clark, of the R.N.D., with us. He was an architect in civvy life, and quite an artist to boot. Well! he filled the bill. His work consisted of painting flowers on the panels stretching right across the semi-circular roof. We rigged scaffolding, sand-papered window frames, and had a cushy time generally.

The church was inside barbed wire. The guards used to leave us there, in charge of the soldier artist, while they went to their barracks, so we did what we liked. Graf von Spee used to come in occasionally. At such times we were busily occupied. He was an imposing-looking man, standing about 6 ft. 4 in. and well proportioned. He often yarned with us.

Matters went smoothly with us, and Williams and I took a turn at painting flowers at the highest part of the roof. They looked quite flower-like from the floor of the church. Jack, the fisherman, and "Nobby" had a heated argument one day which ended with Jack betting him five marks he could paint a panel as well as he. The bet was accepted, and I held the stakes. The panels were about 15 inches square. A paper stencil with a sketch of the design was laid on the square, and a soot bag was pressed against the stencil, leaving the outline of the flowery design on the panel. The filling in was done with different colours, not a very difficult task.

Jack scaled the scaffolding, and with his head to starboard and his tongue to port started in. Well! it was a gaff. The only lines that made a boundary for him were the sides of the panel, and when he had finished, what should have been a delicate tulip looked like a cabbage run to seed. I had to take it out with turps. He paid his bet like a man.

Our life ran along in pleasant channels for some weeks. "Nobby" got a "square number" in camp; so did Rispin, and we three carried on. Kottrop, the artist, became quite friendly. Jack's actions and blunt manner amused him greatly. More than once he sent him to the other end of the church for something he didn't want, just to see him roll, for Jack always walked as if he were aboard ship in a gale.

Kottrop, as soon as he had finished the church, was to report himself for military duty. He was in no hurry to complete his task, and to this aim we willingly assisted him. Our work was supposed to have been completed in six weeks, but we wangled six months on this job.

During the winter months it was extremely cold in the church, as there was no heating apparatus, so we took down a set of gloves and had two or three rounds every morning. The two German soldiers who were helping were very interested, saying "Doesn't it hurt?"

Jack kidded one of them, called Schmidt, to have them on; we retired to the Graf's robing room, and these two started. After a little shuffling about, Jack planted a right to Schmidt's solar plexus, which finished the exhibition. The German took it the right way, but he would never have the gloves on again.

Our routine now was: 8 o' clock a.m. at the church, started painting 8.30, light lunch at 10 a.m. The Graf had a silver electric kettle which he used for making coffee. We found it very useful also for making hot drinks. The organist came in unexpectedly one day and when he saw the kettle he nearly threw a fit. He said, "If the Graf had seen that I should be sent to the front and you would be put in cells." We calmed his fears with a cup of cocoa and continued to use the kettle, though he didn't know it.

The organist was not a bad fellow. He held the rank of corporal in the German army, and was always in a blue funk of being sent to the front. He came in one day in a brand-new uniform. I celebrated the occasion by upsetting a pot of red paint over his new overcoat. He was struck dumb with horror, and Jack didn't improve matters when he said, "Criky! that's done it," and went into fits of laughter. The organist used about half a can of turps on his overcoat and removed most of it, but his coat always bore a mark.

We carried on in the church until Christmas. We left work about 2 p.m., getting back in lager for a game of football nearly every day. The lager authorities seemed to have forgotten our existence, although a postern was always detailed for the church, until one day we were told that we should not be required at the church any more. This was a sad blow to us, but as we had finished the painting nearly three weeks before we hadn't any grounds for complaint. The hours of work in September were from 6.45 a.m. till 4.30 p.m. The men took their lunch with them, and were allowed half an hour pause for rest and refreshment.

September 10. Another shooting incident. A Frenchman, who was a mental case, was strolling about at the hospital. The barbed wire fencing was being repaired, and this Frenchman walked through the gap and stood looking about him. It was about 11 o'clock in the morning, and several men, who were waiting in the enclosure for medical attention, called out to the fellow to come back. He took no notice. The German guard, who was not 10 yards away, yelled out something and instantly fired, killing the man on the spot.

At the beginning of the month the whole camp was shifted from Döberitz Barracks to "Hunger Hill," in tents. This was the original camp that we left a year ago.

On September 18 a working party made an interesting discovery. They were told off to empty rubbish tins, and in one tin was found hundreds of our letters torn up. No wonder our people complained that they received no news. I saw these letters myself, and some were just acknowledgments of parcels received, a clear proof that this destruction was not on account of censorable matter.

October 3. It was very cold in the tents, but in spite of this, an order was given out that no man should have more than two blankets. This may not seem much of a hardship to one who does not know what German kriegsgefangenen blankets are like, but as each man had about four and was then unable to keep warm, it will give some idea of the texture. A few tattered and torn remnants were handed in, but this, as expected, did not satisfy the German quartermaster, who instituted a search with armed guards. The number of ingenious hiding places are too numerous to mention, but the best in my opinion was when a "school" removed the rubbish from one of the large iron rubbish boxes measuring about 10 by 5 ft. square, laid some 40 blankets therein, covered them with paper, and then dumped the rubbish on the top.

I rolled my blankets up and put them in the sleeves of my overcoat and left it hanging in the tent. This device was also successful.

After an all-day search they had found only about one-tenth of the requisite number. Then came the inevitable "unless all extra blankets are handed in all parcels will be stopped for a month." They had us groggy, but we got back at them, as nearly every man tore the blankets in halves as he deposited them on the heap. We had to hand them in to British N.C.O.'s, and of course they didn't object.

October 11. 500 Russians from Novo Georgovitch made their appearance. They were in an awful condition, absolutely starving. One of our men threw some tea-leaves outside the tent. A Russian standing by scooped them up and devoured them. We had known hunger, but not such as this. Little did we think that such hunger was to be the lot of some of us before another year elapsed.

During November we had hard frosts. The insides of the tent were coated with frost. There were 400 of us in one tent, with one stove. Only those near the stove got any warmth. Men ate all their meals with their overcoats on, and on some nights sleep was impossible. A large number of men were falling sick, and the number increased so rapidly that even the Germans decided it was necessary to get us into huts as soon as possible. The temperature was 20° below freezing for about a week prior to moving into huts. We had no sooner moved into huts than a gale sprang up and three large tents went to glory, greatly to the amusement of the "gefang."

We received news that Miller of the R.N.D., who had made his escape from the lager, had landed in Denmark. He received a commission in the R.A.F. later, and was killed in 1917.

Christmas Day, 1915, a day that will long linger in the memory of the Döberitz prisoners of war. Having by this time become familiar with the country, arrangements had for some time been made with German civvies to supply liquor. The boys determined to celebrate this Christmas, and some thousands of bottles of schnapps and other stuff were smuggled into the camp. All parties were searched upon entering, and any man found with liquor received fourteen days.

The fun started on Christmas Eve. We made a collection of spare grub and handed it over to the Russians. A Russian doctor, who was employed at the hospital, visited our barracks to thank us on behalf of the Russians. He had just finished a speech in our hut, and a good deal of cheering ensued, when in bounced a German officer and two guards. The officer demanded lights out immediately. This was at 9 o'clock. We had made a request for lights until 10 p.m., which was granted by the commandant.

Petty Officer M., who was in charge of our hut, and who was half-seas-over, told the officer to clear out as he was in charge and wasn't going to be interfered with by any damned German. He then laid his hand on the German. The two guards made a rush and M. was pulled back by some of the boys just in time. The officer and the two guards went out and up to the guard-house, and turned out the guard. There was an ominous sound of clicking magazines, and the party marched towards our barracks. Half-way across they were stopped by the deputy officer in charge of the lager. Thus another shooting spasm was nipped in the bud.

The officer of the guard exceeded his duty by coming into the lager, without permission of the acting commandant. M. received 14 days; he was lucky.

The next day hardly a man was sober. It didn't take long to make a man "see red" on this stuff commonly called "fixed bayonets." Plenty of scraps took place, old grievances were aired, challenges to fight any man in the place were issued by men of all sizes. In fact it was difficult to walk down the room without getting tangled up with some one. It was a gay old time. The whole camp was placed under punishment for a month in consequence of this celebration by General von A., who inspected the camp shortly after this affair. No sports or recreation; every man to be in bed at 7 p.m.: no lights and no talking; the guards were ordered to fire at any light in the barracks seen after 7 p.m. We were jolly glad when the month was up.

(*To be continued*).

METHOD OF SURVEYING STOPE-FILLING

AT THE BRITISH BROKEN HILL MINE.

By E. F. HARRIS, Chief Surveyor at the Mine.

The author describes an instrument, in the nature of a home-made dial, devised by him for surveying the stope-filling as delivered by contractors.

On the British Broken Hill mine the stopes after the extraction of ore are filled with residues from the treatment plant, known locally as "skimps." The stopes vary greatly in each dimension, from 8 to 140 ft. wide, and any length up to hundreds of feet. The height is usually from 12 to 14 ft., but this factor is governed greatly by the standing qualities of the ore-body and its walls and a series of faults that affect both. Stoping is by means of a series of horizontal cuts, usually from wall to wall across the lode and travelling from winze to winze lengthways. The winzes are in the ore-body (Fig. 1) and are used to convey the skimps underground from the aerial tram that distributes them on the surface.

All filling, locally skimping, is paid by contract. The contract is paid by the number of yards spread in the stope. Truck tallying gave very incorrect results, and was also very expensive owing to the scattered nature of ore-bodies, so it became necessary to estimate each job and pay by results. This entails careful measurement of each stope. In some of the smaller stopes the theodolite was found inconvenient, and very inconvenient to carry through ladderways. Also the rough usuage that it got, and the penetration of fine quartz particles from the skimps into the bearings made it advisable to find some other method.

Time is a big factor in these measurements. Several stopes must be measured by each surveyor and his assistant in the half shift at the end of each contract period of a fortnight. Magnetic work was out of the question owing to the air and water pipes, trucks and truck lines, and drill steel in stopes. An instrument that would give a survey as accurate as could be plotted on a scale of 30 ft. to an inch was wanted. The author designed the instrument shown in the drawing (Fig. 2). It has been found very satisfactory for the purpose, and

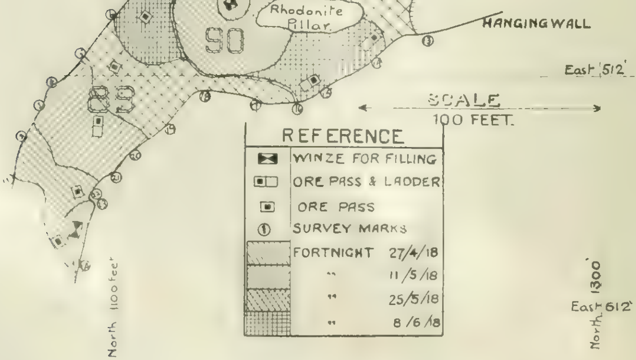


Fig. 1. Plan of the Workings, showing the Method of Filling.

also filling in after a main traverse has been established. It can be read to 15 minutes, but 30 minutes is found quite close enough in practice. It is light and strong and easily set up, and the weight complete is $4\frac{1}{2}$ lb. If damaged there is nothing that cannot be easily replaced. With the exception of the legs (which are a Kodak tripod and adapter) the whole was made in the mine workshop.

The instrument is known as a "protractor table." (*A*) is a $\frac{1}{4}$ in. threaded hole for attaching the adapter and legs, (*B*) a brass web carrying a circular cedar support (*E*) on which is fixed a steel pin (*D*) and two level bubbles (*F*). A brass plate No. 13 gauge (*H*), on which are two folding sight vanes (*C*), revolves on the pin (*D*). (*G*) is the portion of the cedar table to which is glued the circular paper protractor. This protractor is a ferro-prussiate blue print. The adapter allows the head to swing in an arc of about 200, and can be clamped in any position by the turn of a thumbscrew. By setting the table vertical the instrument can be used for vertical angles.

The method of working is to set up anywhere that commands a good view of the stope, if possible under or over a definite point such as the corner of an ore pass or a rise or winze; then sight and measure all the points that can be picked up, proceeding as if using the theodolite. No attempt is made to obtain the correct meridian. This is obtained afterward by plotting on tracing cloth and superimposing on the working plans, when it can be got from known points such as winzes, rises, and ore passes, or instrument stations in main traverses. This is, of course, not needed for the filling calculations, but is very handy in such an irregular ore-body for following development of stopes. All points sighted in the stopes are numbered with chalk. This gives points to check to when measuring the filled stope.

The traverse is plotted with the aid of a paper protractor and a parallel ruler. The protractor is the same as the one on the instrument but larger, a 14 in. centre being found the most useful size. This allows about 400 ft. in length to be plotted with lifting the protractor. Areas are measured with a planimeter. Vertical heights are measured at 10 ft. intervals in the stope and the contour and heights are plotted in black ink, also the numbers on the wall and ore passes, etc., in black.

Before the contract party starts in the stope it is usual to run in as much skimps as will rill away without handling. This, of course, varies with the height and shape of the stope. This is also plotted in black. At the end of the fortnightly period of the contract the outline of the skimps spread is obtained by triangulation from the known points in the stope. The heights are measured from the back to the top of the skimps in the same positions as previously. The difference between the average heights multiplied by the superficial area equals the cubic contents.

If the backs are very irregular (as a rule they are flat) care must taken to get the vertical heights at the same points each time.

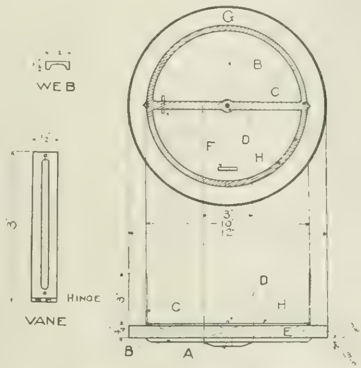


Fig. [illegible]. The Protractor Table

With a rill or bad back the points are marked by means of a candle held on the end of an 8 ft. tamping stick. A black spot within a circle is used to mark the point and the mark will last indefinitely. Distances are taken to halfway on the rill of skimps. It was found that the plotting of the top and bottom of the rill was not needed in practice.

The contour and heights for the first fortnight are plotted in red, the next fortnightly pay period in green, and so on in various colours till the job is complete. By putting the date on the edge of the plan in the colour used for that fortnight a separated record is kept. This plan is open to the perusal of the contractor should he wish to check any measurements.

As many as 15 separate parties are working each fortnight on the skimping contracts, and the yardage handled for the year ended June, 1918, was 45,182 yards.

NOTES ON CYANIDING

By W. B. BLYTH, M.Inst.M.M.

The author, who has had much experience in the treatment of complex gold ores in Australia and Rhodesia, discusses the effect of arsenic and antimony, and the position of flotation as regards gold metallurgy.

ARSENIC.—There is a wide-spread belief among cyanide men that the mere presence of arsenic in an ore stigmatizes it at once as being refractory. Nowhere is this belief more prevalent than in Rhodesia. I have yet to learn that arsenic influences the extraction one way or the other when the cyanide process is used. For a long period I cyanided raw a concentrate composed mainly of mispickel, and obtained 95% recovery of the gold contents. I have frequently successfully treated by raw methods ores containing smaller quantities of arsenical minerals. I think the arsenic bogey has its origin in the frequent association of arsenic with pyrrhotite, antimony, and graphite. The first two minerals cause premature precipitation of the gold almost as fast as it goes into solution if they are present in sufficient quantity. Graphite varies in its behaviour according to its age, and the occluded hydrocarbons present. If arsenic is associated with the above minerals, trouble is sure to arise, and the arsenic generally gets all the blame. Semi-oxidized ores of arsenic are difficult to treat, but the trouble is usually due to acid ferrous salts rather than the arsenic. Arsenic sometimes causes trouble with amalgamation, and sometimes does not; but one scarcely uses the term refractory in connection with a constituent of an ore that merely causes trouble with amalgamation. Roasted arsenical ores do not as a rule yield such a good extraction as roasted pyrite ores with arsenic absent. One is usually lucky if one gets an 87% recovery from a roasted ore rich in arsenic. But the ore should not be roasted unless other troublesome elements are present, or unless the arsenic is wanted.

ANTIMONY.—I have never been able to cyanide successfully by ordinary raw treatment an ore containing appreciable quantities of antimony. Nor have I seen any record of anyone else doing it. The problem has provided the chemical crank with an excuse for spending very large sums of money, and many promising processes have been built up in the laboratory, only to fail in practice. I have had certain experience with antimonial ores during the last few years, and the development of the present method of treatment which yields a high percentage recovery is of interest. The determination of the exact antimony content of the ores being treated has never been attempted owing to the lack of competent chemists. But from the act that a considerable tonnage of pure stibnite can be picked from the ore during a few months, it is apparent that the antimony is present in appreciable quantity. Years ago when antimony was first detected in these ores its presence was immediately followed by a plentiful supply of alkaline sulphide in the cyanide solution. The extraction became so bad that the cyanide process was discontinued while detailed experimental work was carried out. Experiments carried out in those days indicated that a roasting furnace was necessary. Roasting antimonial ores is not a satisfactory process. A certain proportion of the gold seems to get alloyed with the easily melted stibnite; and nothing on earth will dissolve the gold in this alloy. While the high-grade concentrate and sand was being roasted, experiments indicated that the gold in the slime could be dissolved after long-continued oxidation in the air. A process was eventually evolved which involved the building of 4 or 5 slime dams. After one dam was full, it was allowed to drain and oxidize for a few months. The surfaces were then ploughed, scraped off, and cyanided. This process was repeated until the dam was finished. Then the next was treated in rotation in a similar manner. Following on this discovery it was found that the gold in the sand and concentrate could be recovered in a similar manner. The oxidation of the antimonial concentrate was very obvious to the eye, the colour gradually changing from a dark grey to a light yellow. When first produced all-sliming in cyanide solution would only yield about 50% extraction. But after six weeks' oxidation with an occasional turning, over 93% extraction could be obtained by similar treatment. This method of treatment was then adopted right through the plants. Concentration was abandoned, as the mineral oxidized just as well in the sand and slime dumps as it did if separated and treated separately. Of late years experimental work has indicated that the ores could be treated direct from the mill, providing no lime was used in the circuit. This has been tried out in practice with satisfactory results as far as the sand is concerned. Owing to the solubility of antimony in alkaline cyanide, it is not possible to add lime to the mills and achieve good results. Consequently the abraded iron which mainly goes with the slime is reduced to the ferrous state and independently of the antimony effectually upsets the extraction from this product when treated direct without lime. In connection with the sand, however, it is found that the residue rises proportionately to the lime used, and the best results are obtained when no lime is used at all. About ½ lb. of lead nitrate is used per ton of ore, and the sand is slimed in an acid solution. The consumption of cyanide is naturally heavy, but the good extraction counterbalances losses in this direction.

The sudden appearance of metallurgical troubles, and the gradual evolution of methods to overcome these troubles is very interesting. I wonder whether the phenomena described might not occur under favourable conditions in other parts of the world. When a consulting metallurgist experiments on a refractory antimonial ore he can scarcely be expected to try out a scheme demanding several months' atmospheric oxidation. Consequently it is not likely that the first method described has been often tried out. Metallurgists are so wedded to the standard alkaline cyanide solution of the text-books that with experimental work they are not likely often to try an acid solution for a change. Gitsham used an acid solution in his process, but went to the other extreme, using sulphuric acid to generate HCN, and regenerating his cyanide with lime afterward. The failure to treat an antimonial ore before, and the successful treatment after oxidation, or before oxidation in the absence of lime, is of interest, and it is possible that the principle can be applied to the treatment of other antimonial ores both in Rhodesia and other countries. I recall my experience when experimenting on the large antimonial lodes of the Gwalia Consolidated gold mines in West Australia, and I regret that experiments on these lines were not carried out there.

ABRADED IRON.—When crushing in neutral or acid water the abraded iron produced quickly oxidizes to the ferrous condition. When lime and cyanide are subsequently added, the formation of ferrous hydrate and ferrocyanide is the natural outcome. Troubles due to these reactions are frequently ascribed to something refractory in the ore. Ferrocyanide is in itself harmless, and is quite a good solvent for gold. Its presence, however, always indicates that bad conditions have existed at some time or other in the circuit. These conditions are frequently caused by the partial oxidation of abraded iron. At other times they are due to the oxidation of iron minerals. Abraded iron from the mill generally finds its way to the slime, as it will not leave the classifiers until actually slimed. If lime is used in the mill this abraded iron will not oxidize. If the slime, after collection, is agitated for some time with air the ferrous oxide will be oxidized to the ferric state, and lime and cyanide may be subsequently added without the formation of ferrocyanide. When crushing in cyanide solution, and if available CaO be present, no oxidation of the abraded iron will take place.

I once undertook comprehensive experimental work at the Great Fingall mine in West Australia, when confronted with a problem due to the presence of abraded iron. The tabulated results obtained were included in a paper published by Mr. G. C. Klug in the June, 1910, number of the West Australian Chamber of Mines Journal. This was the first published information in this connection that I know of, although later there was quite a lot of interest displayed in the subject on the Rand.

The abraded-iron trouble is disastrous in two ways: (*1*) the precipitation of gold by ferrous hydrate, and (2) the excessive consumation of cyanide due to conversion into ferrocyanide owing to interaction with ferrous salts.

FLOTATION IN GOLD METALLURGY.—In a paper read before the Australasian Institute of Mining Engineers in 1914, I reviewed the position in this respect, and as far as I can see the position is much the same now. Before 1914 the Etheridge gold mines, in Queensland, used the flotation process for the separation of copper from an ore which they subsequently cyanided and treated in a vacuum filter annexe. According to information received by me from the metallurgist, Gerald Blayney, the metallurgical results were excellent, but the mill subsequently closed for reasons connected with ore production. The concentrate on this mine, containing copper and gold, was sold to the smelters. It still appears that from the gold-mine point of view the sphere of usefulness of the flotation process is confined to the removal of refractory mineral prior to cyanidation. Experimenting in West Australia in 1912, I could take Kalgoorlie telluride ore worth 40s. per ton, and reduce it to 3s. with the production of from 10% to 15% of concentrate. To effect the result, however, the ore had to be reduced almost to a colloidal slime. The expense of doing this was very great, and this, as well as the question of the subsequent roasting prior to cyaniding of the floated slimed concentrate, does not make the proposition a very attractive one. I never could prove that I could successfully cyanide this or other flotation concentrate by ordinary raw methods. I have seen no indication in the technical press that anyone else has solved this problem. Anyone who has attempted to roast slimed concentrate prior to cyaniding knows the almost insuperable difficulties that will be encountered. As the leading flotation process does its best work when dealing with slimed ore, it would seem obvious that a mixed concentration plant would be the only one that would yield a concentrate that could be roasted successfully. The extraction by flotation of a concentrate that would yield its gold to raw treatment would always be a doubtful economic proposition, even if the ore values were concentrated in a 10% product. If the concentrate can be treated by raw methods, then by hydraulic classification it can be slimed in the circuit without sliming everything else. Then the problem is which is the best economic process, (*a*) to cyanide and filter the whole product, or (*b*) to float the whole product, and cyanide by some means yet to be ascertained. If the total residue from (*a*) is lower than that from (*b*), then (*a*) will in my opinion always be the best proposition. Personally I predict, as I predicted in 1914, that it will never pay to float a mineral from an ore that will yield its gold to an all-sliming process. Flotation will, however, some day play a prominent part in floating refractory mineral from low-grade ores, and this concentrate will be roasted and cyanided, or smelted, according to local conditions. The Falcon mine in Rhodesia is the only mine in Africa employing the flotation process. This is a copper-gold mine, and the concentrate is smelted. The tailing is too low in gold to make cyaniding profitable.

LETTER TO THE EDITOR

Malayan Geology.

The Editor:

Sir — In your November issue, under "Malayan Geology," Mr. J. B. Scrivenor, Government Geologist to the Federated Malay States, criticizes adversely my paper on "The Secondary Stanniferous Deposits of the Kinta District," and makes some disparaging remarks about the conduct of the officers of the Geological Society with reference to that paper.

I do not purpose to enter into a controversy with Mr. Scrivenor. It is unnecessary, because in his recent paper on "The Origin of the Clays and Boulder Clays, Federated Malay States," published in the *Geological Magazine* for April, 1918, he shows very clearly that he has almost completely abandoned his glacial theory of the origin of these deposits. He states that he has definitely done so in the case of some of the mines in Kinta formerly described as being on glacial clays. He still, however, has some lingering doubt about a few small patches of clay in a few restricted areas in Kinta Valley.

I do not for a moment think he would wilfully misquote me. My experience has been that anything written against the glacial origin of the Kinta deposits acts as an irritant on him, and this appears to explain why, in quoting from my paper, he has given the beginning and end of a sentence, and has missed out certain words essential to its meaning.

For example, on page 256, paragraph 9, Mr. Scrivenor states that "On page 186, Dr. Jones says kaolin is characterized by its 'non-plasticity.'" Turning to page 186, I find that what I wrote is as follows: "Kaolin, however, is characterized, *as a clay*, not by its plasticity, but by its non-plasticity."

If Mr. Scrivenor will refer to Searle's translation of Emile Bourry's "Treatise on Ceramic Industries" (1911), to Ries' "Clay, its Occurrence, Properties, and Uses" (1912), or to Allen Howe's "Handbook to the Collection of Kaolin, etc., in the Museum of Practical Geology, Jermyn Street" (1914), he will find that koalin is, as I stated, one of the least plastic of all clays.

The point of interest, however, relative to the degree of plasticity of kaolin is that Mr. Scrivenor advanced a theory that certain clays *in contact with granite* had escaped metamorphism because they were rich in kaolin, and hence more plastic than other clays in the same area, which had been metamorphosed.

So far, Mr. Scrivenor has made no attempt to question the correctness of my statement that 90% of the tin-ore produced from Kinta District is from mines situated within a distance of less than a mile from the junction of the granite of the Main Range and the Kledang Range, or from granitic intrusions contemporaneous with the granite of these ranges.

He simply states that this leaves 10% of the Kinta production "out in the cold."

It is not from want of opportunity that he has refrained from attacking these highly significant figures, for they were given in my article in *The Mining Magazine* for October, 1915, and for many months after their appearance Mr. Scrivenor lived within ten minutes' walk of the Mines and Survey Departments of Kinta, where all the information was immediately available. The 10% was not left out "in the cold" of the glacial beds, but in alluvial deposits which had been carried more than a mile from a known granitic intrusion. These alluvial deposits are, in part, now being worked by the Malayan Tin Dredging Co.

The following brief history of the theories as to the origin of these Kinta tin ore deposits is full of interest:

September, 1910. Mr. Scrivenor described the Gopeng Beds[1] as being the remains of a very ancient tinfield that formed part of "Gondwanaland," and as having been transported by glaciers or sheets of floating ice.

1913. The glacial clays and boulder clays were described[2] and shown in his geological sketch map accompanying his memoir on the Kinta Valley as covering a considerable area, and it was definitely stated on page 35 of that memoir that the bulk of the tin-ore in these deposits was ice-borne and derived from the lost continent of Gondwanaland.

July, 1914. Mr. Scrivenor, in an article[3] in the *Geological Magazine*, states that the glacial theory best explains the facts in the field.

June, 1915. I read a paper[4] before the Geological Society in which I endeavoured to show that it was unnecessary to bring in glacial action and "Gondwanaland" to explain any of the features which led Mr. Scrivenor to adopt that theory. I put forward a theory that appeared to explain, in a simple manner, the origin of the tin-ore in these deposits, and showed that all the tin-ore was derived from rocks now *in situ* in the Kinta District.

October, 1915. A summary of my paper appeared in *The Mining Magazine*.

November, 1917. The above paper was published by the Geological Society.

April, 1918. Mr. Scrivenor wrote an article[5] in the *Geological Magazine* in which he abandons his glacial theory so far as some of the largest mines in Kinta Valley are concerned. Of the famous Tronoh mine he now states: "It might be argued with reason that taking this mine alone the former (shales weathered and broken up over dissolving limestone) is the better explanation, and that the tin-ore was introduced by granitic intrusions. . . . . . " At Gopeng he now states that the beds could, in places, be interpreted as stratified beds disorganized by sinking on the limestone. At Siputeh, the mine from which the angular tin-ore was photographed and published in the Kinta memoir to illustrate tin-ore carried by ice, Mr. Scrivenor now writes: "One must conclude that the boulders are not of a glacial origin but are the remains of a tin lode in shale and quartzite overlying limestone." In short, it is quite clear from this article that Mr. Scrivenor is on the point of completely abandoning his glacial theory.

November, 1918. In a Letter to the Editor of *The Mining Magazine* Mr. Scrivenor touches on a completely new theory, namely, that Kinta Valley is an old sea-strait modified by river-action. It is an interesting theory, but there appear to be very strong arguments against it. No sea-shells, for example, have been found in the Kinta Valley despite the fact that in scores of open-cut mines deposits have been washed for tin ore for years. Mr. Scrivenor concludes the above letter by stating that he ventures to think he has stated the case against the glacial theory better than I have. That is a small matter; the important point is that the theory should now be definitely abandoned in the interests of economic geology and the mining industry of Malaya.

WILLIAM R. JONES.

Tavoy, February 8.

[1] Report on Prospecting Work at Gopeng by the Government Geologist No. 13, Kuala Lumpur 1910, p. 3.

[2] Geology and Mining Industry of the Kinta District 1913, p. 35.

[3] *Geological Magazine*, July, 1914, p. 309.

[4] The Origin of the Secondary Stanniferous Deposits of the Kinta District, F.M.S. *Q.J G.S.* vol. lxxii, part 3, 1917.

[5] The Origin of the Clays and Boulder Clays, F.M.S. *Geological Magazine*, April, 1918.

Salt in South Africa.—It is often supposed that rock-salt is not found in South Africa. Attention may be drawn to the fact that a few years ago Dr. Versfeld reported an occurrence of rock-salt in what was then German South-West. It forms a low plateau in the neighbourhood of Elizabeth Bay some district south of Luderitzbucht, between Luderitzbucht and Pomona, several miles from the coast. Dr. Versfeld investigated only one edge of this plateau. There is a little escarpment of cliffs about ten to twelve feet high, and these cliffs consist of rock-salt. The deposit is described in his paper on "The Geology of German South-West Africa," read before the South African Association for the Advancement of Science in 1914.

NEWS LETTERS.

NORTH OF ENGLAND.

ERRATUM.—In my last notes I estimated that the stocks of pig lead now held by the Government had cost approximately £50 per ton in warehouse; through a misprint it appeared as £30, making my argument look absurd. If all changes of freight and administration were added the figure would probably be above £50.

THE METAL POSITION.—Your correspondent "Skiddaw" has described the situation of the home mines with some force, and I was much struck with his reference to the Imperial German mines in the Hartz mountains. Generally we have imagined that the Germans must have been extremely short of metals, among them, spelter, as, in 1913, they imported 313,269 tons of blende, and the home production was not considered sufficient to keep them going. It is evident that there must have been a large and rapid increase in the *internal* production, as from figures now available we find that the production of spelter in the later war years was as follows: 1916, 196,500 tons; 1917, 186,500 tons; 1918 (10 months) 198,000 tons. The military requirements were fully satisfied, despite the blockade, and it is fair to assume that the policy described by "Skiddaw" was an important factor. It is obviously most important to preserve our home lead, zinc, and tin mines, as the time might arrive when they were absolutely vital to the existence of the country. If the Government had allowed the prices of our ores to rise in proportion to the cost of production, the output would have risen enormously during the last few years, instead of which the home mines were treated as if they were a nuisance, and kept alive by miserable doles, grudgingly administered, and the result has been disaster.

Some mines have received loans to meet estimated capital expenditure, but in certain cases further financial support is withdrawn and the companies are left stranded. For instance, the Government fathered the comprehensive Halkyn District pumping scheme, and the papers extolled the wise foresight of the Government in providing a central pumping plant to drain several mines. The work was nearly finished, when the Treasury stepped in and stopped the whole thing. If this decision is adhered to, the money already spent will be practically wasted, and the money spent on developments at the mines lost.

As the Mineral Resources Department is now dissolved, except for the controller, Mr. Cunningham, I wonder if it is too late to suggest that one or other of these gentlemen be transferred to the Board of Trade, so that the information on home mining may not be altogether lost? The reports on the mines and mining districts obtained in the past three years are of national importance, and should be made available to those who might be inclined to take up developments.

INTERVIEWS WITH THE GOVERNMENT.—There have been several meetings of the Mine Owners and Unions in London lately, and the former had an interview with Mr. Percy Ashley, of the Board of Trade. Those who were present refuse any information, but it is evident that the whole situation was most carefully considered. Mr. Ashley entered into the details of the industrial and economic position, and I can see that a most favourable impression was created by his attention to the statements submitted to him. He has a wide knowledge of industrial matters, and was Professor of Economics at Birmingham University for some years. If he will seriously tackle the problem of the non-ferrous mines he will find that the injustices suffered during the war demand that the Government should generously help the mines at this juncture. I understand that the Mine Owners asked for an inquiry into the position of the industry, and I hope this will be granted.

FEDERATION OF MINE OWNERS.—On Thursday, April 3, a meeting was held to form a Federation of Mine Owners, to include lead, zinc, copper, tungsten, barytes, gypsum, &c., this being necessary to carry out the Whitley scheme. I hope all owners will join it at once, so that it may represent the whole of the industries. It should be pointed out that the Government says it will only deal with Industrial Councils, and the formation of this federation is a necessary preliminary.

LABOUR POSITION.—The Mine Owners are much worried by the withdrawal of the refund of the Coal Controller's awards on March 31. The Government insists that before any further payments of arrears are made the Lead and Zinc Association must formally withdraw any claims to the extension of the date. Very large sums are now due, and the action of the Government is disgraceful. It is one way of choking off a creditor, for it was obviously the duty of the Government to meet the obligations that it had incurred. The awards should have been cancelled on the same date as the withdrawal of the refund, but now the mines have in fact to pay an advanced rate of about 18s. per week with a steadily falling revenue. The awards are, however, compulsory, and *must be paid* to the men, and the Ministry of Labour says that if a mine cannot work in these circumstances it can always stop. Of course it can. In the meantime mines are stopping, and men are being thrown out of work, their source of livelihood is being destroyed, and they can leave their homes and villages and join the army of men and women supported by "donations." The folly of the Government is quite incredible, and it will be a crime against the community if the Wages (Temporary Regulation) Act is extended beyond May 21. The Labour Unions state that it is to be kept in operation until December 31 at least, and I suppose they know, but it should be clearly understood that under its provisions no employer may reduce or adjust his wages in a downward direction. He has to continue to pay his higher rates, plus the Coal Controller's awards, and can make no arrangements with his men to meet the reduction in prices that he is now faced with.

The men must receive their pound and a half of flesh, or else obtain from the overworked Labour Registers the donation, a small proportion of which would have kept their employment in being. In several cases the men have approached the employers with a view to some modification of the wages basis, but the owners are helpless, and I anticipate general stoppage of the weaker mines or the withdrawal of the output bonus in June.

One of the largest builders in the kingdom told me that his estimate staff were working night and day, but that when the cost of buildings was presented, the private schemes were dropped at once. The public building schemes will go on, because the Government (you and I) are to meet the loss, but he did not anticipate any renewal of extensive operations for a long time. The restriction of rents is an absolute barrier to private enterprise. With no demand for lead from the building trades the immediate outlook is not very bright. The price is sagging away for both lead and zinc, and the value of the ore is reduced in proportion. The contract for the purchase of blende by the Government ceases on May 5, and producers will then have to make private terms with the smelters. I think that some effort should be made by the Association to pull the blende producers together, and arrange a course of united action. I have no doubt but that the Smelter's Association could give information as to how this could be most effectively accomplished.

News from the Mines.—In my district, our premier lead mine, Greenside, has difficulties that have nearly stopped production, and the Braithwaite mine (Force Crag) is in a similar position through the erection of new power plant. Mr. G. F. Wallace, the late manager, has retired and the reins are in the hands of Mr. H. I. Stretton, who will, I trust, bring the mine into the producing list on a fairly large scale. Thornthwaite mine is turning out about 75 tons of concentrates per month, the development of the south end of the mine having been successful. I see that the managing director, Mr. Anthony Wilson, has been offered and accepted a seat on the board the Weardale Lead Co., and that Mr. E. P. Deas has been appointed chairman. Mr. Deas is known to all the North Country Mines as chairman of Messrs. J. Cameron Swan & Co., Ltd. Mr. Ernest Thomas has resigned from the management of the Shropshire Mines Ltd. Mill Close mine, Derbyshire, is now in the hands of Mr. H. F. Collins (late of the Mineral Resources Department) and I hope he may have an easier task than Mr. Stuckey. There seems perennial labour trouble in this district and the management must be no easy post.

CAMBORNE.

Proposed Subsidy for Cornish Tin Mines.—At the time of writing, no news is to hand of the decision of the Government in the matter of financial assistance to the mines to enable them to tide over the next few months until conditions get more settled. In reply to a question on the subject recently asked by Mr. Acland in the House of Commons, Mr. Bridgeman, the Parliamentary Secretary of the Board of Trade, replied that a decision would be reached in a few days. We have reason to believe that a recommendation has been made by the Committee of the Imperial Mineral Resources Bureau that temporary assistance should be given pending a general investigation and inquiry by the Government, and probably the Treasury is the obstacle which causes the hesitation. After all, State subsidy to key industries is no new departure for this Government; agriculture has been subsidized, and so has coal mining to some extent. The lead and zinc mine-owners of this country are similarly asking for financial assistance, and recently sent a deputation to the Board of Trade, following the lead of the tin-mining industry. We have urged in these columns before that the industry as a whole has not hitherto represented its grievances to the Government as vigorously as it should have done; all interests dependent or partly dependent on the industry should have been organized in active protest against the apathy hitherto shown by the Government. Cornwall is a far cry from Whitehall, and the protest must be of such a character as to cause a flutter in the dovecotes of the permanent officials; they are so used to receiving deputations and appeals for assistance of all kinds, that nothing short of a sort of bombshell will set them moving. It would also be well to get repeated questions on the subject asked in the House of Commons; the Minister in charge will then probably realize that he must look into the matter. Cornwall must, in fact, wake up if the industry is not to be allowed to decline seriously.

It is interesting to note that no one member of the Sub-Committee of the Imperial Mineral Resources Bureau has any intimate knowledge of non-ferrous mining in this country. Why is it that the Government usually selects men to deal with a matter about which they have all to learn? No wonder there is delay.

EAST POOL & AGAR.—In these depressing times for Cornish mining, it is heartening to read the report of the operations of this company for the year ended December 31 last, for which the eminently satisfactory net profit (after allowance has been made for Excess Profits Duty and depreciation) of £103,784 was earned. This compares with a net profit for the previous year of £59,651. When one remembers that the total capital of the company is only £120,000, such a profit earned in one year must be gratifying to those shareholders who had the faith and courage to risk further capital a few years ago in a mine which some local pessimists persisted in regarding as worked out.

The recent history of East Pool & Agar is one of the romances of mining, and there is reason to anticipate that, given average conditions, the mine will long remain among the world's leading tin producers, and continue to earn handsome profits for its shareholders.

The tonnage milled shows a reduction of 1,886 tons as compared with the previous year, namely, 75,401 tons, and the ore extracted from the Rogers lode has increased from 34 to 55% of the total handled. It cannot therefore be said that the ore-body now known as the Rogers lode, but which in reality has been worked under other names in the old East Pool mine, has been worked out of proportion to the ore reserves of the mine as a whole, which was a fear expressed in some quarters.

The following figures of production will be of interest:

	Tons Recovered	Realization price. Total	Per ton	Yield per ton milled lb.	Shillings
		£	£		
Black tin	1 280	249 544	195·0	38 03	66·19
Wolfram	57	10,237	179·5	1 70	2·72
Tin scheelite	2	241	135 0	0 05	0 06
Arsenic	420	30,495	72·6	12·47	8·09
	1 759	290,517		52·25	77 06

The average chemical assay of the ore milled during the year was 33·82 lb. metallic tin per ton and the average value of the tailing was 9·57 lb. metallic tin per ton.

It is satisfactory to note that the percentage of lost time on the part of the miners continues to show a reduction; in 1916, it was 6·9%; in 1917, 6%; and in 1918, 4·86%.

The operating cost has increased from 30s. 9·71d. in 1917 to 50s. 8·29d., but as will be seen from the following comparative figures, a large part of this increase is due to the provision of Excess Profits Duty, which, from a costing point of view, is not an operating expense:

	1917 per ton milled s. d.	1918 per ton milled s. d.
Development	4 7 62	7 4 08
Pumping	3 8 53	5 0 63
Mining and Trucking	6 10 67	9 1 05
Winding	1 10·60	2 7·52
Rock breaking	7 68	8 06
Transport of Ore	7 78	7 83
Freight and Carriage	1·95	4·29
Milling	3 7·37	3 11·41
Concentrating	2 1·52	2 3·55
Dressing	1 6·37	2 0·25
Assaying	1·74	2·74
Surface Repairs and Maintenance	10·60	1 3·10
	26 10 43	35 6 51
General expenses, including rates, royalties, depreciation, Excess Profits Duty	3 11·28	15 1·78
	30 9·71	50 8 29

Very little of what is termed "main development" was undertaken during the year owing to shortage of labour, but two exploratory boreholes disclosed promising ore-bodies. At the 190 fm. horizon, the diamond-drill located, 230 ft. north of the Rogers lode, ore averaging 37 lb. black tin per ton over a width of 10 ft. This same lode, located in the killas at the 212 fm. level, did not carry payable values. At the 240 fm. level east, the drill intersected what appears to be a portion of the Rogers lode north of the elvan, and this averaged 32 lb. of black tin and wolfram per ton for a width of 5 ft. Other values, averaging about 20 lb. were cut by a continuation of this bore.

It is anticipated that the two top sections of the electrically-driven pumps, which will raise the water in three stages, will be ready to make a start this month, and this will relieve the considerably over-taxed Cornish pump at Agar's shaft.

During the year, dividends to the extent of 2s. 6d. per 5s. share were declared, and with a view to conserving the cash resources of the company, the directors recommend capitalizing a sum of £30,000 of the undivided profits, so increasing the authorized capital to £150,000 by the creation of 120,000 new shares of 5s. each, which it is proposed to distribute among the shareholders in the proportion of one for every four shares held on April 16. Doubtless the shareholders will regard this as a very acceptable Easter gift. It is noteworthy that the investment in Government securities falls short of the issued capital of the company by a sum of only £1,677.

DOLCOATH.—The result of the working of this famous old mine for the six months ended December 31 last proved to be rather more favourable than was generally anticipated. A profit of £14,446, or, after allowances for depreciation, a net profit of £11,917, is satisfactory in its way, but if the normal amount of development work could have been undertaken, such expenditure would have made a considerable hole in this profit. It is well to give publicity to this fact, or otherwise the Government will be asking why financial help is needed. It is certain, too, if existing conditions continue during the whole of the current half-year, that this profit will be probably more than absorbed by the losses now being made. At December 31 last, the difference between the assets (excluding property, plant, buildings, and shares in West Dolcoath, Ltd.) and the liabilities (excluding share capital and debentures) was £46,967, and this, in effect, is the real reserve of working capital. If this is to be seriously reduced by losses, then there will certainly be insufficient funds available for the exploitation of the North and South Roskear setts and some of the other promising points for exploration which have been referred to from time to time by the managing director, R. Arthur Thomas. For the six months in question, 28,716 tons of ore was milled, being a decrease of 4,067 tons on the previous half-year. The produce (31·45 lb. per ton), however, was up by 2·48 lb. per ton, so that the tin concentrate sold was only approximately 21 tons less, namely, 403 tons. The working cost shows a further rise to 47s. 9d. per ton, as compared with 23s. 10d. for the last complete half-year before the war, or a rise of slightly over 100%. While on this subject, it might not be out of place to suggest that some shareholder should inquire when the details of the operating cost will be set out in such a form as to be of real service to those interested in the subject. Dolcoath management should be in the van in the matter of issuing data which will be of service to the industry generally, and we cannot think that the information is not available, for no mine can be said to be well handled where a proper costing system is not in operation. The development carried out during the six months was only 266 ft., and it is deplorable to find that the development footage for 1918 was less than one-tenth that of the year 1914. It is reported that the scheme of diamond-drilling has been completed with the exception of boring below the present bottom workings, but this will be undertaken shortly. From the speech of the managing director, it is evident that he has no great hope of locating any considerable high-grade ore-bodies in Dolcoath, such as would place the mine once more in the premier position as a tin producer in Cornwall, although he evidently thinks that, with adequate development, the present position can be maintained. He has, however, high hopes of finding profitable tin ground away to the north in the Roskear setts, which have hitherto only been worked in the killas; it is anticipated that at a depth of about 300 fm. the killas is replaced by granite, and it is in the granite that Mr. Thomas hopes to find profitable tin lodes. It is evident that a scheme of exploration in this direction is under consideration, similar to that planned by Messrs. Bewick, Moreing & Co. for the exploration of Tolgus, namely, a main drivage from Dolcoath, which would come in under the bottom of the old North and South Roskear workings and so avoid shaft-sinking, and even unwatering, if the result of the exploratory work was disappointing. Such a scheme will cost a lot of money, but from all we can learn, given normal conditions, it should prove a very fair speculation.

SOUTH CROFTY.—This company is an easy first, so far as the West of England is concerned, in the matter of profit earned for 1918, when the nominal capital is taken into consideration, though it has to be remembered that much of the working capital was raised by the issue of shares at 300% premium. The profit was £67,554 on an issued capital of £50,000. This profit is subject to Excess Profits Duty, but we should judge that the net figure would more than equal 100% on the issued capital. Dividends paid or to be paid from the year's profits equal 3s. 6d. per 5s. share. It is now proposed to capitalize £50,000 (being £28,500 taken from share premium reserve account and £21,500 from the reserve account) by creating 200,000 new shares of 5s. each, bringing the capital of the company up to £100,000 and then to issue to the shareholders by way of bonus one new share for each one held on June 30 next. Why so long ahead is something of a mystery. In 1918, 70,055 tons of ore was crushed and the production was as under:

	Yield		Value		
	Total Tons	Per ton lb	Total £	Per ton s.	d.
Black tin	610·3	19·51	84,438	24	1·27
Wolfram	87·8	2·81	14,725	4	2·44
Arsenic	828·4	26·48	40,388	11	6·36
Sundry Products			431	0	1·49
				39	11·56

The development equalled 3,572 ft., or one foot for every 20 tons milled, and in addition 2,703 ft. of boring was carried out. The costs at the mine were 34s. 10·81d. per ton milled. The result of actual development work was on the whole disappointing, but an irregular body appears to have been located between Robinson's and Palmer's shafts at the 180 and 205 fm. levels, and in a winze below the 205. Several thousands of tons of ore averaging 24 lb. tin and wolfram, and 30·5 lb. (equivalent in pyrites) arsenic per ton has already been proved, and the manager is rather hopeful that this discovery will considerably add to the ore reserves. The prospects are also good for opening up ore values above the average of the mine in the cross-cut north at the 290 fm. level east of Robinson's shaft. This ground has already been tested by the diamond-drill, the core showing three separate lodes giving payable values.

GEEVOR.—From a circular just issued, it appears that the whole of the 60,000 shares recently offered to the shareholders have been allotted, and the debentures redeemed. The manager reports that the mine continues to open up satisfactorily, that there are underground now 20,000 tons of broken ore ready for milling, and that the reserves already amount to several years' supply for the existing mill. Shareholders will doubtless be glad to see these reserves converted into cash; the pity of it is that circumstances made it impossible to take full advantage of the high price of tin last year. For the 18 weeks ended March 26 last, the production of tin concentrate was 139½ tons, which realized £19,203. This rate of production makes Geevor the fourth largest producer in Cornwall. The duplication of the mill is proceeding, and in the course of a few months the output should begin to show an advance.

YEAR BOOK OF CORNISH CHAMBER OF MINES.—We have had occasion from time to time to criticize the dilatory methods of the Cornish Chamber of Mines, so that it is a particular pleasure to draw attention to the promptness of the Chamber in issuing official statistics for the year 1918, and also to express our commendation for the excellent year-book which has just been issued. The editor, Mr. Harold Fern, has secured a "scoop" in the matter of the statistics of mineral production of the West of England for the years 1914 to 1917, for these statistics have not hitherto been published, the publication of the usual mineral statistics prepared by the Home Office authorities having been suspended during those years. The book is replete with useful information relating to the present position of the industry; details are given of the constitution of each company operating mines in Cornwall and Devon, and of the output for 1918 of the majority of the mines, while a bibliography is included of the literature published during 1918-19 dealing with non-ferrous mining and metallurgy in the West of England. Tables are given of diamond-drilling costs, and also of the working costs of several Cornish mines, while a chart is presented which effectively illustrates the increased cost of materials during the war. Articles on the geology of Cornwall, on the School of Metalliferous Mining, and on a number of other subjects, accompanied by much useful data go to make up a very complete record of the history of the West of England mining during the year 1918. Accompanying the year-book is a map of Cornwall, showing the position of the mines which are working to-day or have worked during the past few years.

TIN MINING AS A "KEY" INDUSTRY. The Government has promised shortly to introduce a Bill which will have for its object the fostering and stabilizing of the key industries of the country, viewed, presumably, from a war point of view. There is little doubt that wolfram mining will be regarded as such; indeed, the Engineering Trades Committee appointed by the Government has already made such a recommendation. But the claim of tin mining to be a "key" industry is by no means generally accepted in Government circles, and it is, therefore, very necessary that the Joint Industrial Council of the Tin Mining Industry should, without delay, prepare its case and press its claims for all it is worth. Procrastination in Cornish mining circles has been one of the evils of the past, but we hope and believe that at last it has been realized that help is usually given to those who first help themselves. The Industrial Council seems a live organization, to judge from the length of its meetings and the vigour of the language used thereat, and we hope this matter will be tackled at its next meeting, even if it means the adjournment of a discussion on the vexed question of the mines urging their employees to join the Unions, which, after all, is not a vital matter, and one which can wait.

TORONTO.

March 11.

PORCUPINE.— The gold-mining industry is showing increased activity, and working forces are being largely increased. At the Hollinger Consolidated 40 additional stamps have been set in operation, more powerful mining equipment is being installed, and before long it is expected that the mill will be running at its full capacity of 2,800 tons daily. The resumption of milling operations at the Dome Mines will, it is understood, take place in May, when Manager Keading will have returned from California. Underground operations in the meantime have been speeded up, and an ample tonnage of ore secured to keep the mill running at its full capacity of 40,000 tons per month. The shareholders of the Dome Extension have ratified the agreement giving the Dome Mines an option on their property for one year, during which the Dome Mines agrees to spend $3,000 per month in development and exploration. It is announced that operations will begin immediately. The workings of the Davidson have been unwatered. A cross-cut is being driven in the ore-body discovered in the shaft at the 460 ft. level to open up a very rich section proved in diamond-drilling. The shaft will be put down to the 700 ft. level. The Sovereign, adjacent to the Hollinger Consolidated, has undertaken diamond-drilling operations to determine the existence at depth of ore-bodies indicated by surface showings. High-grade ore of a good width has been found in the shaft at 65 ft. At the Porcupine Keora five veins found on the surface have been cut by diamond-drilling at depth.

BOSTON CREEK.— The Miller Independence is sinking a new central shaft to be put down vertically to about 600 ft., at which point it should meet the vein. It is proposed to continue it to a depth of 900 ft., and to tap the ore on the lower levels by cross-cutting. Diamond-drilling on the Cotter property has disclosed an ore-body 28 ft. in width at a vertical depth of 492 ft. The average gold content found in the diamond-drill core amounted to $12·42 per ton. Buffalo capitalists, represented by George Morris, have bought the McCrea-O'Neill property, adjoining the Miller Independence, and the Charlebois-Authier group of claims adjacent to the Cullen-Renaud, and will begin development as soon as possible. The Allied Gold Mines has obtained satisfactory results from diamond-drill work on the O'Donald property. The company is sinking a shaft on the Cullen-Renaud, which is now down 50 ft. with encouraging results. Arrangements are being made for an early resumption of operations at the Patricia, which was closed last fall owing to the difficulty of obtaining fuel, and labour shortage.

KIRKLAND LAKE.—The Lake Shore mine, since it commenced milling on March 8 of last year, has produced up to the same date of 1919 a total of $515,892, the last few weeks being estimated. The January output was $45,162 tons, the ore treated averaging $26·12 per ton. A small steam plant is being transported to the Canadian Kirkland preparatory to commencing work. The ore on this property is stated to contain a higher silver than gold content, which is exceptional for this district. The new 30 ton mill of the Burnside has been completed and put into operation. At the Ontario-Kirkland the new mining plant is now being operated by electric power. The shaft will be put down to 300 ft.

COBALT.—The annual statement of the McKinley-Darragh shows production of the net value of $815,902, and cost of production including depreciation $473,735, leaving a gross profit of $342,167. After deducting administration expenses, taxes, etc., the net profit was $295,662. The ore reserves were estimated at 852,754 oz., and the cash in hand was $234,772. Silver production of the Kerr Lake in January was 118,952 oz., as compared with 102,289 oz. in December. During the first ten months of 1918 the monthly output exceeded 200,000 oz. The annual statement of the Trethewey showed production valued at $250,534, with operating costs of $147,166, leaving an operating profit of $103,368. Ore reserves had decreased to 159,172 oz. The ore treated was of low grade and production was only profitable by reason of the high price of silver. The annual report of the Adanac showed an expenditure of $31,000, leaving $15,000 on hand. The company has shipped 150 tons of ore, some of it of high grade. At the Reliance the shaft has been put down to the 100 ft. level and a substantial quantity of ore is being extracted.

PERSONAL.

GEORGE BARGATE, JR., has been appointed assistant manager of Dolcoath.

ALAN M. BATEMAN, of Yale University, has been appointed editor of *Economic Geology* in succession to the late J. D. Irving.

A. J. BRETT, manager of Crown Mines, has been appointed one of the technical advisers to the Transvaal Chamber of Mines, in place of David Wilkinson, who has returned to England.

CAPTAIN WALTER BROADBRIDGE has left for the Continent.

C. B. BRODIGAN has been appointed manager of the Brakpan mine.

GELASIO CAETANI has retired from the firm of BURCH, CAETANI, & HERSHEY, of San Francisco. LLOYD C. WHITE has joined the firm, which will now be known as BURCH, HERSHEY, & WHITE

S. W. CARPENTER is home from Nigeria.

HENRY F. COLLINS has retired from his temporary position with the Ministry of Munitions as Chief Engineer of the Mineral Resources Department, and is resuming private practice. He has been appointed consulting engineer to the Mill Close lead mine, Derbyshire.

SAMUEL F. COOK has returned from Nigeria.

MAJOR H. T. CURTIS, R.E., is going to the El Oro mine, Mexico

A. A. DAVIDSON is on his way home from Nigeria.

C. R. DAVIS, manager of Brakpan, has succeeded C. E. Knecht as consulting engineer to the Consolidated Mines Selection group.

COURTENAY DE KALB, lately associate editor of the *Mining and Scientific Press*, is going to Spain as a member of a commission appointed by the United States Government to investigate the mining and metallurgical resources of that country.

EDMUND P. DEAS has been elected chairman of the Weardale Lead Company.

W. SHAW DUNCAN has returned from Nigeria.

PROFESSOR FEDERICO GIOLITTI, of Turin, has been awarded the Bessemer Medal of the Iron & Steel Institute for 1919.

O. T. GORTON has left the service of the Wolfram Mining & Smelting Co., Ltd., operating in Portugal, to become assistant manager of the Pentor mine belonging to the Anglo-Peninsula Mining Chemical Co., Ltd., at S. Joao da Madeira, Portugal.

MAJOR G. A. HARRISON, D.S.O., M.C., R.E., lately commanding a tunnelling company, has been demobilized and has returned to England.

WILLOWS HILDRED is home from South America.

HERBERT C. HOOVER retires from the United States Food Administration in July, and will return to mining work, with headquarters at New York.

J. P. HUTCHINS has returned from the United States and is going to South Russia.

JOHN M. ILES is on his way home from Nigeria

JAMES JOHNS took over the management of Witwatersrand Deep on March 1.

F. W. LINCK is here from Burma.

MAJOR T. M. LOWRY has been here from Italy for a short time.

D. H. MCDOUGALL, of the Nova Scotia Steel & Coal Co., has been elected president of the Canadian Mining Institute.

J. H. MCMILLAN, Inspector of Mines at Prince Rupert, B.C., has resigned the position on being appointed general manager of the Jasper Park collieries, Alberta.

W. W. MEIN has gone to Nicaragua

JAMES NEGUS has left London on his return to the Mount Boppy gold mine, New South Wales, travelling by way of Canada.

JOSEPH F. ODGERS has been appointed secretary of Dolcoath Mine, Limited.

MAJOR H. G. PAYNE is home on leave.

HERBERT C. PORTER, for many years secretary of the Consolidated Gold Fields of South Africa, has been elected to the board.

G. G. L. PREECE, Lieutenant Lancashire Fusiliers T.F. and R.E., has been demobilized and has returned to his old post as branch manager of the Manchester district for Bruce Peebles & Co., Ltd., Edinburgh. His address is as heretofore at 30, Cross Street, Manchester.

The two leading members of the firm of Lionel Robinson, Clark & Co., namely, LIONEL G. ROBINSON and WILLIAM CLARK, are retiring, and the business will be carried on by the remaining members under the name of Knight, Jessop, and Stanton.

WILLIAM RUSSELL, London manager for the Dorr Company, has returned from the United States.

DR. J. C. STAMP has resigned as assistant secretary of the Board of Inland Revenue to become secretary of Explosives Trades, Limited.

W. E. THOMAS is here for Nigeria.

H. T. WALSH, of the Sullivan Machinery Co., has left London on his return to the United States.

A. J. WALTON, manager of Rose Deep, has been appointed manager of Crown Mines.

ANTHONY WILSON has joined the board of the Weardale Lead Company.

LOUIS A. WRIGHT is expecting to arrive home in New York from Chile about the middle of this month.

A. E. V. ZEALLEY, curator of the Rhodesia Museum, was one of the many victims of the influenza epidemic. He took his A.R.C.S. in 1908, and subsequently became demonstrator in geology at South Kensington. After making a study of the metamorphosed limestones of Donegal, he went to the Rhodesia Museum, and afterwards joined the Geological Survey of Southern Rhodesia. He did much for the development of the Rhodesian ore deposits. The premature end of a promising career is greatly to be regretted.

TRADE PARAGRAPHS

LOW & BONAR, LTD., of Dundee, send us charts showing the movements in prices of raw jute and hessian cloth during the years 1914 to 1918.

JAMES KEITH & BLACKMAN CO., LTD., of 27, Farringdon Avenue, London, E.C., have sent us their catalogues of ventilating machinery for mines.

THE YUBA MANUFACTURING COMPANY, well known as a builder of dredges, has moved its office from San Francisco to Marysville, California

ORD & MADDISON, LTD., Victoria Works, Darlington, have issued an elaborate calendar for 1919 and 1920, illustrating their stone-breakers, grinding mills, elevators, screening plant, etc.

GEORGE KENT, LTD., of 199–201 High Holborn, London, W.C., and Luton, send us pamphlets relating to their apparatus for the measurement of compressed air and water flow operating on the Venturi principle.

THE PACIFIC TANK & PIPE CO., of San Francisco and Los Angeles, send us catalogue No. 12 containing information relating to their wooden tanks, vats, and pipes, made of California redwood. They specialize on the erection of plant required in cyaniding and leaching processes.

QUILLIAM, LIMITED, of 12, College Lane, Liverpool, send us their latest pamphlet describing their sacks and bags for holding ore and concentrate. The pamphlet describes the various uses for bags of this character, the sizes of the bags, and the materials of which they are made. Particulars are also given of the firm's sample-bags.

HUGH WOOD & CO., LTD, of Newcastle-on-Tyne, send us their catalogue of auxiliary hauling plant for mines. These are driven by either compressed air or electricity, and are of both single and double drum type. Special recommendation is given to the compressed air motors of the turbine type. The firm's machines are made to standard patterns so as ensure low prices and prompt delivery

PETTERS, LIMITED, specialists in semi-Diesel oil engines, of Yeovil and Ipswich, announce that the Ipswich works, which were purchased during the war by Vickers, Limited, are to be handed over to a new company, Vickers-Petters, Limited, of which the sole shareholders will be the two firms named. Mr. E. W. Petter has been appointed managing director for a period of five years. The Yeovil works remain the property of Petters, Limited.

THE CONTINUOUS REACTION CO. LTD., of Battersea, London, S W., makers of ferro-alloys, inform us that they have entered into an arrangement with Nobels Explosives Ltd. to combine their business with that of THERMIT, LTD. Nobels have nominated to the board of the Continuous Reaction Co. two of their directors, Lt.-Col. the Hon T. H. A E. Cochrane, chairman of Thermit, Ltd., and H. J. Mitchell, general manager of Explosives Trades, Ltd. John J. Skelley, of the Continuous Reaction Co., will continue, as managing director of the joint undertaking.

BOVING & CO. LTD., of 56, Kingsway, London, W.C 2, announce that their works at Stoke-on-Trent have been remodelled and are to be further extended This firm, well known for water-power plant, used to factor out their work to various shops in this country, and imported machinery from Sweden. Two years ago they acquired works at Stoke-on-Trent. The number of men employed is being increased from 300 to 600. At the present time three turbines of 3,000 h.p and two of 8,000 h.p. are in course of construction. Designs are being prepared for units of 16 000 h.p.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO., LTD., of Cambridge, send us an illustrated folder giving particulars of special catalogues relating to power-plant instruments, as follows: Electrical distance thermometers, thermo-electric pyrometers, indicating thermometers (mercury in steel), recording thermometers (mercury in steel), glass thermometers for steam plant, indicating draught gauges, recording draught gauges, vacuum recorders, pressure recorders, carbonic acid recorders, reproductions of carbonic acid records, fuel calorimeters, automatic temperature regulators.

VICKERS, LIMITED, have during the last few years built a new village for their men near Barrow-in-Furness, Lancashire, They did not wish employees to go dry, yet they did not want to encourage the sale of intoxicating drinks. In erecting the George Hotel they adopted the principle of Earl Grey's Trust, according to which the manager is paid a commission on food and non-alcoholic drinks sold but none on the intoxicants. This hotel overlooks the Irish sea, and in the neighbourhood are tennis, football, and cricket grounds, bowling greens, and golf links. The founding of this community provides an example of the new method of handling labour problems to which reference is made in our editorial columns this month.

THE BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO., LTD., of Manchester, send us the report and accounts connected with their Employees War Relief Fund covering the period from August 22, 1914, to December 31, 1918. Of the total contribution, amounting to £63,150, £41,359 was contributed by the employees, and £21,791 by the company. Out of this sum, £45,097 has been paid to dependents, £12,764 set aside for a disablement and dependents' fund, and £2,890 has been spent in donations to local and national funds and Christmas gifts. The number of families in receipt of weekly relief is now 820, and the number of employees who have joined His Majesty's Forces is 3,516. The number of employees who have lost their lives is 296, and the number of widows on the list is 117.

THE SULLIVAN MACHINERY CO., Chicago, have issued a number of new bulletins recently relating to air compressors as follows: 75-D, single-stage straight-line steam-driven compressors, class WA-5. 75-E, straight-line simple-steam and two-stage air-compressors, class WB-3; this is the familiar two-stage straight-line machine, which the firm have built for a number of years past, but which has now been re-designed to incorporate the end-rolling finger or plate type of valves, improved speed and pressure regulator, and steam valve motion, and other new features. 75-G, class WG-3 single stage and class WH-3 two-stage belt-driven compressor, standard pattern. 75-I, underground mine car compressor, class WK-2, complete with motor, electrical fittings and receiver for operating coal pick machines, hammer-drills, etc, a popular type in quite general use, especially in coal mines. They have also issued 72-C Sullivan drill sharpening machine of the all-hammer pattern; this bulletin includes mention of the newly designed Sullivan double arc-drill bits, which are fitted with double taper on the wing, together with the adjustable vertical gauging dies in which this double taper wing is made.

METAL MARKETS

COPPER.—The market has shown some revival of general interest during the past month, and dealings in standard copper have tended to increase. Values have, at the same time, been inclined to improve, this remark applying particularly to forward delivery. Refined copper has also shown a better tone, and prices have slightly advanced. Generally speaking, more confidence is now shown in the intrinsic position of the metal, and an increased interest has been shown by consumers of the refined article, as well as of manufactured material. In the case of the latter, a good inquiry is seen for material required in the building of locomotives, as well as for different descriptions of hammered work, while more actual business has been consummated with India. In America the market remained for the most part rather dull, but latterly business seems to have brightened up somewhat. This has been attributed in some quarters to the possibilities of Peace becoming an accomplished fact before long, and the consequent raising of the blockade upon enemy countries, with an expected demand for the metal from Germany. In the meantime the production in America is gradually being curtailed, the average curtailment throughout the country in January being put at about 30%. This looks like being carried further in subsequent months, as it is known that some mines have had to close down altogether owing to prevailing conditions. In regard to the surplus stock of copper held by the United States Government, it

DAILY LONDON METAL PRICES: OFFICIAL CLOSING PRICES ON
Copper, Lead, Zinc, and Tin per Long Tons; Silver

	Silver	Copper: Standard Cash		Copper: Standard (3 mos.)		Copper: Electrolytic		Copper: Best Selected		Lead: Soft Foreign	
March	d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
12	47¼	76 0 0 to	77 0 0	72 0 0 to	73 0 0	80 0 0 to	76 0 0	80 0 0 to	76 0 0	28 0 0 to	25 10 0
13	47¼	76 0 0 to	77 0 0	72 0 0 to	72 10 0	80 0 0 to	76 0 0	80 0 0 to	76 0 0	28 0 0 to	25 10 0
14	47¾	76 0 0 to	77 0 0	72 0 0 to	72 10 0	80 0 0 to	77 0 0	80 0 0 to	77 0 0	28 0 0 to	25 10 0
17	47¾	76 10 0 to	77 10 0	72 15 0 to	73 5 0	81 0 0 to	78 0 0	80 0 0 to	77 [illegible] 0	28 0 0 to	25 10 0
18	47¾	78 0 0 to	79 0 0	74 10 0 to	75 0 0	81 10 0 to	78 10 0	81 10 0 to	78 10 0	28 0 0 to	26 10 0
19	47¼	77 10 0 to	78 10 0	74 0 0 to	74 15 0	82 0 0 to	79 10 0	81 10 0 to	78 10 0	28 0 0 to	27 0 0
20	47¾	77 0 0 to	78 0 0	74 0 0 to	74 10 0	82 0 0 to	79 10 0	81 10 0 to	78 10 0	28 0 0 to	27 0 0
21	47¾	77 0 0 to	78 0 0	75 0 0 to	75 10 0	82 0 0 to	80 0 0	82 0 0 to	80 0 0	28 0 0 to	27 0 0
24	47¼	77 0 0 to	78 0 0	75 0 0 to	75 10 0	82 10 0 to	80 10 0	82 0 0 to	80 0 0	28 0 0 to	27 0 0
25	49 1/16	78 10 0 to	79 10 0	76 10 0 to	77 0 0	83 0 0 to	81 0 0	83 0 0 to	81 0 0	28 0 0 to	27 0 0
26	49 1/16	78 10 0 to	79 10 0	77 0 0 to	77 10 0	83 0 0 to	81 0 0	83 0 0 to	81 0 0	28 0 0 to	27 0 0
27	49 1/16	78 10 0 to	79 10 0	77 0 0 to	77 10 0	[illegible] 10 0 to	81 10 0	83 0 0 to	81 0 0	28 0 0 to	26 10 0
28	50	78 0 0 to	78 10 0	76 15 0 to	77 0 0	[illegible] 10 0 to	81 10 0	83 10 0 to	81 10 0	27 0 0 to	26 0 0
31	49¾	78 0 0 to	78 10 0	76 0 0 to	77 0 0	84 0 0 to	82 0 0	83 10 0 to	81 10 0	27 10 0 to	26 0 [illegible]
April											
1	49 1/16	79 0 0 to	79 10 0	77 10 0 to	78 0 0	84 [illegible] 0 to	82 0 0	84 0 0 to	82 0 0	27 0 0 to	25 0 0
2	49 1/16	80 0 0 to	81 0 0	79 0 0 to	80 0 0	84 10 0 to	83 0 0	84 0 0 to	82 0 0	26 10 0 to	25 0 0
3	48¾	80 0 0 to	80 10 0	79 0 0 to	79 10 0	84 10 0 to	83 0 0	84 0 0 to	82 0 0	26 0 0 to	24 0 0
4	48 15/16	78 0 0 to	79 0 0	78 0 0 to	78 1[illegible] 0	84 10 0 to	83 0 0	84 10 0 to	83 0 0	25 0 0 to	23 10 0
7	48 1/16	79 0 0 to	79 10 0	79 0 0 to	79 10 0	84 10 0 to	[illegible] 0 0	84 10 0 to	83 0 0	25 0 0 to	23 0 0
8	48¾	78 5 0 to	78 10 [illegible]	78 5 0 to	78 10 0	84 10 0 to	[illegible] 0 0	84 10 0 to	83 0 0	25 0 0 to	23 10 0
9	48 15/16	77 10 0 to	78 0 0	77 10 0 to	78 0 0	84 10 0 to	[illegible] 0 0	84 10 0 to	83 0 0	25 0 0 to	24 0 0
10	48 15/16	77 0 0 to	77 10 0	77 0 0 to	77 10 0	84 10 0 to	82 0 0	84 10 0 to	83 0 0	25 0 0 to	24 0 0

appears that arrangements have been made to dispose of this gradually over a period of some fifteen months, so that it seems likely that this will be liquidated without any serious effect upon market prices. As regards Australia, advices from Melbourne state that owing to the slump in copper the Great Cobar mine had decided to shut down, and later news indicates that there may be a general suspension of mining operations in Australia owing to present conditions. The increase in the Government stocks of copper on March 1 of more than 9,000 tons had no adverse effect on the market here, which has since become firmer, first on signs of a rising tendency in Atlantic freights, and also on the new conditions ruling in regard to the American rate of exchange.

Copper ores have been quiet; those containing 15 to 25% are quoted at 11s. 7½d. to 12s. 1½d. nominal per unit

Average prices of standard copper: March 1919, £76. 17s. 7d.; February 1919, £78. 10s. 3d.; March 1918, £110. 5s.; February 1918, £110. 5s.

The February imports of copper were 14,258 tons against 12,497 tons last year.

TIN.—A good deal of activity has been witnessed in this market during the period under review, and at times the speculative open account appeared to amount to very considerable proportions. Owing to the large invisible supplies of the metal in the Straits, Batavia, and even in China, rather a bearish view was taken of the future of values. Since then, however, the viewpoint seems to have somewhat altered, partly on the report that the Government of the Federated Malay States in association with the Government of the Dutch East Indies, proposed to arrange a minimum price for the metal, which would apply not only to Straits, but also to those brands which are exported from Batavia. This created a feeling of greater confidence, although it was still believed that the stocks in Java must amount to a considerable quantity. Subsequent reports, however, indicate that fairly large sales have been made to Switzerland. It is stated, indeed, that the Swiss Government has purchased some 600 tons of Banka and Billiton tin, and consumers in that country a further 100 tons. Thus it may be that stocks in Batavia are not quite so important as it was supposed, and therefore the menace to the market is certainly less severe than was imagined. In the meantime stocks in this country have remained fairly light, although some good arrivals have recently come in, and some improvement has been seen in this respect. The shipments from the Straits for the first half of March to this country are, however, comparatively light, amounting to only about 150 tons, so it may be that a lean period may be seen again in regard to arrivals for some time to come. Business with consumers here can only be described as of moderate dimensions, the constant fluctuations in the market having impaired confidence. The activities of the tinplate trade in South Wales, however, look like increasing, so that a better outlet in this direction should be assured in the future. Export inquiry has not been particularly brisk, and English tin has only been in quiet demand. The situation in America remains much as before, although the stocks there are apparently being gradually got rid of, and it may not now be so long until that country once more enters the world's markets as a buyer of tin.

Average prices of cash standard tin: March 1919, £236. 18s. 5d.; February 1919, £224. 3s. 4½d.; March 1918, £318. 15s.; February 1918, £311. 12s. 3d.

The February imports of tin were 587 tons against 697 tons in 1918 and 2,193 tons in 1917.

LEAD.—This market has not seen any very material change during the past month, except that latterly there has been a distinct sign of growing confidence on the part of consumers, and a fairly good demand has been seen, in which the makers of electrical cables participated. Some further quantities have also been released for export, but there still seems room for more business in this direction, and in some quarters it is expected that a renewal of the inquiry from neutral countries is now about due. America, in the meantime, has apparently been experiencing a better home demand, while production there is, of course, being considerably cut down. In consequence, offers from that country to this side were much less pressing, and as a result values of forward metal showed some improvement. The Government stocks on March 1 showed an increase on the month of no less than

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter) £ s d £ s. d.	Standard Tin Cash £ s. d £ s d.	Standard Tin 3 mos. £ s d. £ s. d.
38 0 0 to 36 0 0	236 0 0 to 236 10 0	229 0 0 to 229 10 0
38 0 0 to 36 0 0	241 0 0 to 241 10 0	232 10 0 to 233 0 [illegible]
38 10 0 to 36 10 0	240 10 0 to 241 10 0	232 0 0 to 232 10 0
38 10 0 to 36 10 0	238 [illegible] 0 to 238 10 0	229 15 0 to 230 0 0
39 0 0 to 37 10 0	238 0 0 to 238 5 0	229 10 0 to 230 0 0
39 0 0 to 37 10 0	236 15 0 to 237 5 0	230 0 0 to 231 0 0
39 0 0 to 37 10 0	238 10 0 to 239 0 0	233 0 0 to 233 10 0
39 0 0 to 37 10 0	237 15 0 to 238 0 0	234 10 0 to 235 0 0
38 10 0 to 37 0 0	238 0 0 to 239 0 0	234 0 0 to 234 10 0
38 10 0 to 37 0 0	237 10 0 to 238 0 0	234 15 0 to 235 [illegible] 0
39 0 0 to 37 0 0	240 0 0 to 240 10 0	236 0 0 to 236 10 0
39 0 0 to 37 0 0	238 0 0 to 238 10 0	235 15 0 to 237 0 0
39 0 0 to 37 0 0	236 10 0 to 236 15 0	234 0 0 to 234 10 0
38 10 0 to 36 10 0	233 10 0 to 234 0 0	232 0 0 to 232 10 0
37 15 0 to 35 15 0	226 5 0 to 225 15 0	224 0 0 to 224 10 0
38 5 0 to 36 0 0	219 10 0 to 220 0 0	217 10 0 to 218 0 0
37 0 0 to 36 0 0	223 0 0 to 223 10 0	221 0 0 to 221 10 0
37 0 0 to 36 0 0	225 15 0 to 226 5 0	223 15 0 to 224 0 0
37 0 0 to 36 0 0	227 0 0 to 227 5 0	225 10 0 to 225 15 0
37 10 0 to 36 10 0	226 10 0 to 227 0 0	225 0 0 to 225 10 0
37 0 0 to 36 10 0	227 10 0 to 227 15 0	225 0 0 to 225 5 0
36 10 0 to 36 0 0	227 0 0 to 227 5 0	225 0 0 to 225 5 0

13,570 tons, but this factor appeared to be more or less ignored in view of the general world position of the metal. In consequence of the fall in price, without any corresponding reduction in freights, labour, mining, and smelting requisites, the Fremantle Trading Co., West Australia, has been compelled to close down its mines. In Spain also, the position has not been at all satisfactory for somewhat similar reasons. The Spanish Customs Duty of 1 peseta per 100 kilogrammes on the export of argentiferous lead has meantime been suspended until May 31. It is reported that the Rhodesian Lead & Zinc Syndicate has been placed in voluntary liquidation, and the lease of the 35 square mile mineral area which includes the Rhodesia Broken Hill Mines has reverted to the Rhodesia Broken Hill Development Co. The syndicate produced 15,383 tons of lead from April 1, 1916, to February 28, 1919. An additional smelter has been ordered, and it is anticipated the output should be increased to 1,500 tons of metallic lead per month

The average prices of soft pig lead were: March 1919, £26. 16s. 11d.; February 1919, £26. 13s.; March 1918, £29; February 1918, £29.

Our imports of lead for February were 29,336 tons, against 17,981 tons in 1918.

SPELTER.—This market showed a downward tendency in the early part of the month, owing to the slack state of the demand, and to the easy conditions ruling in the American market; but latterly a better tone has been noticeable, and more business has been doing with consumers. Costs of production are understood to be above the selling value of the metal in America The same has been said in regard to costs in this country, which have been put at over £50 per ton, while English spelter was selling at about £40. Meantime the labour trouble at New York harbour created the possibility of delayed shipments from that side, while the rising tendency of freights and the fall in exchange have all tended to improve the position of the metal in this country. Advices from Australia mention that in the Australian parliament it was stated that the zinc concentrate contract with the Imperial Government had virtually assured new life for Australian zinc mines. The total value of metals (which presumably includes copper and lead) and concentrates paid for by the Imperial authorities was 7 million sterling.

The average prices for good ordinary brands were: March 1919, £37. 10s. 3d.; February 1919, £42. 11s. 6d.; March 1918, £52; February 1918, £52.

Our imports of spelter for February were 9,138 tons, compared with 3,365 tons last year.

ZINC DUST.—Australian 88-92% is quoted at £80 per ton f.o.r. Liverpool, and English zinc dust about 75% at £70 per ton at works.

ANTIMONY.—There is little fresh in this market, English regulus continues to be quoted at £45 per ton, with a quiet demand. Meanwhile foreign material in warehouse is variously quoted at prices ranging from £35 to £40 according to the quantity required.

ARSENIC is quiet at about £35 for white delivered in London.

BISMUTH is quoted nominally at 12s. 6d. per lb

CADMIUM.—7s. 9d. to 8s. 6d. per lb.

ALUMINIUM.—£150 per ton to the home trade.

NICKEL.—£195 per ton for home trade.

COBALT METAL.—12s. 6d. to 13s. per lb.

COBALT OXIDE.—7s. 9d. per lb

PLATINUM.—360s. to 440s. per oz.

PALLADIUM.—Quoted nominally at 500s. per oz.

QUICKSILVER.—About £15. 10s. to £16 per flask.

SELENIUM.—12s. to 15s. per oz.

TELLURIUM.—95s. to 100s per oz.

SULPHATE OF COPPER—About £48 f.o.b. for export and about £47 for home trade.

MANGANESE ORE.—Indian about 2s. 1d. to 2s. 3d. per unit. According to a trade report from Monte Video pockets and traces of manganese are found in practically all parts of Uruguay, but the majority are too small or poor to make exploitation worth while. One of the principal deposits is found in the Department of Riviera near the Arroyo Zapucay. It is estimated that 80 million tons could be taken out by open-cuts. The analysis shows an average content of 54·8% iron, 22·7% manganese, 9% silica, 0·03% phosphorus, and 0·05% sulphur. So far as is known the only manganese deposit in Uruguay being worked on any scale is a 16 ft. vein located at the Pantanoso, near Monte Video.

WOLFRAM ORE.—Wolframite 65% is quoted at 40s. and scheelite at a similar price to approved consumers. Owing to the great accumulations here, the Ministry of Munitions has given notice terminating all existing arrangements with colonial mine-owners as and from April 30

MOLYBDENITE is nominal. The arrangements with colonial producers are to be cancelled as and from April 30.

SILVER.—The American quotation has been steady at 101⅛c., but the changes in the rate of exchange have created fluctuating prices here. At the end of the month of March standard bars were quoted at 49¾d. per oz.

CORUNDUM.—Forward shipment is quoted about £18 per ton c.i.f.

GRAPHITE is quoted at £45 for 80%, c.i.f. U.K.

IRON AND STEEL.—The markets generally have been rather upset by the various uncertainties consequent upon the labour unrest, not to mention doubt as the future course of prices. The pig-iron markets have been fairly active, but the scarcity of foundry iron has prevented much export business being done in that article, although licences were readily obtainable. In finished iron and steel, works are pretty well occupied in the meantime, and the export inquiry seems to have widened. Competition from America seems likely to be a factor in the future of this market. Control and subsidies will be withdrawn on April 30.

STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL

	Rand	Elsewhere	Total	Value
	Oz	Oz	Oz	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
Year 1916	8,971,359	324,179	9,295,538	39,484,934
Year 1917	8,714 866	307,527	9,022,493	38,32[illegible]
January, 1918	694,121	19,991	714,112	3,033,653
February	637,571	22,188	659,759	2,802,477
March	677,008	19,273	696,281	2,957,614
April	697,733	19,366	717,099	3,046,045
May	720,539	20,778	741,317	3,148,915
June	708,908	18,788	727,696	3,091 058
July	716,010	20,189	736,199	3,127 174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	3,008,267
October	667,955	11,809	679,764	2,887,455
November	640,797	17 904	658,701	2,7[illegible]
December	630,505	10,740	641,245	2,723,836
Year 1918	8 197,959	221 734	8,419,693	35,768,[illegible]
January, 1919	662,205	13,854	676 059	2,871 718
February	621,188	15,540	636,728	2,704,047

NATIVES EMPLOYED IN THE TRANSVAAL MINES

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1918	176,424	11,469	4,715	192,608
February 28	181,066	11,243	4,825	197,134
March 31	183,055	11,076	4,745	198,876
April 30	182,492	11,322	4,753	198,567
May 31	179,879	11,211	4,773	195,863
June 30	179,028	11,473	4,747	195,248
July 31	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September 30	179,399	12,108	4,889	196 395
October 31	173 153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	160,599	11,848	3,539	175,986
February 28	172,359	11,868	4,261	188,488

COST AND PROFIT ON THE RAND.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s d	s d	s d	£
January, 1918	2,167,411	27 1	20 7	6 4	703,665
February	1,946,338	27 8	21 7	5 11	577,396
March	2,107,561	27 1	21 4	5 8	596,109
April	2,181,609	27 0	20 8	6 2	670,871
May	2,237,644	27 3	20 6	6 5	716,963
June	2,124,205	28 2	21 0	6 11	736,694
July	2,167,869	27 10	21 2	6 6	702,360
August	2,158,431	28 1	21 7	6 3	676,146
September	2,060,635	28 2	22 0	5 10	600,330
October	2,015,144	28 0	22 5	5 3	531,774
November	1,899,925	28 5	23 1	5 1	480,102
December	1,855,991	28 7	23 0	5 6	507,860
Year 1918	24 922 763	27 11	21 7	6 0	7,678 1[illegible]

PRODUCTION OF GOLD IN RHODESIA AND WEST AFRICA

	Rhodesia.		West Africa	
	1918	1919	1918	1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	232,023	220,885	112,865	112,616
March			112,605	—
April	239,916		117 520	—
May	239,205		126,290	—
June	225,447	—	120,273	—
July	251,740		117,581	—
August	[illegible]		120,526	—
September	[illegible]		115,152	
October	136,780	—	61,461	
November	145,160	—	108,796	
December	192,870	—	112,621	—
Total	2,652,[illegible]50	432,802	1,333,553	216,679

TRANSVAAL GOLD OUTPUTS.

	February, 1919	
	Treated	Value
	Tons	£
Aurora West	11,700	11,681
Bantjes	—	—
Brakpan	41,300	80,925
City & Suburban	—	—
City Deep	40,000	78,330
Cons. Langlaagte	41,000	49,414
Cons. Main Reef	41,610	66,181
Crown Mines	124,000	182,843
Durban Roodepoort Deep	25,000	37,290
East Rand P.M.	103,500	132,907
Ferreira Deep	31,700	49,078
Geduld	39,500	58,673
Geldenhuis Deep	42,500	49,904
Ginsberg	10,500	11,683
Glynn's Lydenburg	3,160	6,040
Goch	12,550	10,876
Government G.M. Areas	101,000	179,658
Heriot	10,100	13,992
Jupiter	22,100	23,989
Kleinfontein	53,500	63,158
Knights Central	20,000	28,129
Knights Deep	77,600	67,411
Langlaagte Estate	38,160	48,919
Luipaard's Vlei	18 860	520*
Meyer & Charlton	11,625	33,402
Modderfontein	78,000	167,746
Modderfontein B	48,000	115,479
Modderfontein Deep	39,700	82,846
New Unified	12,300	11,039
Nourse	32,600	46,581
Primrose	15,600	15,316
Princess Estate	20,000	24,706
Randfontein Central	135,000	153,191
Robinson	35,800	41,560
Robinson Deep	36,000	49,178
Roodepoort United	23,330	22,408
Rose Deep	47,500	55,067
Simmer & Jack	37,100	44,164
Simmer Deep	37,900	42,058
Springs	35,300	68,022
Sub Nigel	8,500	24,037
Transvaal G.M. Estates	12,850	18,356
Van Ryn	31,100	31,059
Van Ryn Deep	43,350	94,990
Village Deep	45,800	58,896
Village Main Reef	17,000	21,522
West Rand Consolidated	28,600	32,778
Witwatersrand (Knights)	30,750	34,944
Witwatersrand Deep	—	—
Wolhuter	26,600	33,231

* Profit

WEST AFRICAN GOLD OUTPUTS.

	February, 1919	
	Treated	Value
	Tons	£
Abbontiakoon	7,415	15,931
Abosso	6,990	11,713
Ashanti Goldfields	7,231	35,578
Prestea Block A	15,190	27,684
Taquah	5,100	14,669
Wassau	2,473	4,768

RHODESIAN GOLD OUTPUTS.

	February, 1919	
	Treated	Value
	Tons	£
Antelope	3,100	5,113
Cam & Motor	—	—
Eldorado Banket	5,084	12,475
Falcon	13,300	26,247*
Gaika	3,045	5,425
Globe & Phœnix	5,298	9 170†
Lonely Reef	4,330	24 666
Rezende	5,200	13,74[illegible]‡
Rhodesia, Ltd.	349	1,112
Shamva	44,283	35,031
Transvaal & Rhodesian	1,700	6,250
Wanderer	9,500	3,680

* Gold, Silver, and Copper; † Ounces Gold; ‡ Gold & Silver

West Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January, 1918	*	73,703	*	*
February	*	76,987	*	*
March	*	69,730	*	*
April	*	66,079	*	*
May	*	73,701	*	*
June	*	74,904	*	*
July	*	72,081	*	*
August	*	76,156	*	*
September	*	74,057	*	*
October	*	71,439	*	*
November	1,444	70,711	72,155	306,491
December	2,739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	*nil*	65,158	66,158	281,120

* By direction of the Federal Government the export figures from July, 1916, to November, 1918, were not published.

Australian Gold Returns.

	Victoria.		Queensland.		New South Wales	
	1917	1918	1917	1918	1918	1919
	£	£	£	£	£	£
January	67,627	32,134	50,150	47,600	25,000	18,000
February	65,450	58,113	63,200	45,470	28,000	24,000
March	74,794	65,412	61,200	48,020	30,000	—
April	75,159	26,849	62,470	47,600	30,000	—
May	65,623	87,885	65,450	46,740	45,000	—
June	64,150	45,765	73,100	51,420	32,000	—
July	68,937	64,347	71,820	51,000	25,000	—
August	101,428	61,163	74,800	44,600	21,000	—
September	61,701	65,751	64,180	45,900	32,000	—
October	33,533	*	54,400	54,400	40,000	—
November	75,912	*	42,380	38,200	25,000	—
December	56,967	70,674	64,170	56,281	38,000	—
Total	846,540	674,655	744,537	578,213	370,000	42,000

* Figures not received.

Australasian Gold Outputs.

	February, 1919	
	Treated	Value
	Tons	£
Associated	5,508	7,839
Associated Northern Blocks (Iron Duke)	—	3,522*
Associated Northern Blocks (Victorious)	1,986	3,016
Blackwater	2,068	3,232
Bullfinch	4,562	4,956
Golden Horseshoe	11,412	22,688
Great Boulder Prop.	11,871	35,599
Ivanhoe	15,597	27,500
Kalgurli	3,265	6,520
Lake View & Star	9,967	11,921
Oroya Links	1,565	9,877†
Progress	1,250	1,954
Sons of Gwalia	10,732	16,455
South Kalgurli	7,141	10,475
Talisman	—	—
Waihi	15,074	24,104‡
Waihi Grand Junction	10,063	15,175§

Surplus; † Total receipts ‡ Gold and Silver to Feb. 22, 18 days. § 42 days to Feb 22.

Miscellaneous Gold Output

	February, 1919	
	Treated	Value
	Tons	£
Barramia (Sudan)	1,058	537
Esperanza (Mexico)	15,685	2,314†
Frontino & Bolivia (Colombia)	2,540	7,715
Nechi (Colombia)	92,213*	13,371‡
Ouro Preto (Brazil)	5,200	7,390
Pato (Colombia)	46,732*	8,038‡
Philippine Dredges (Philippine Islands)	—	367§
Plymouth Cons. (California)	10,200	12,181
St. John del Rey (Brazil)	—	35,000
Santa Gertrudis (Mexico)	30,360	21,50[illegible]††
Sudan Gold Field (Sudan)	1,900	[illegible]147

* Cubic yards, † Profit, ‡ Dollars; § Ounces, fineness not stated
†† Profit gold and silver

Production of Gold in India

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	162,270
February	183,264	180,904	173,343	153,775
March	186,475	189,618	177,950	162,790
April	192,208	185,835	176,486	—
May	193,604	184,874	173,775	—
June	192,469	182,426	174,375	—
July	191,404	179,660	171,950	—
August	192,784	181,005	172,105	—
September	192,330	183,630	170,360	—
October	191,502	182,924	167,740	—
November	192,298	182,388	157,176	—
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	478,835

Indian Gold Outputs.

	February 1919	
	Tons Treated	Fine Ounces
Balaghat	[illegible]	2,042
Champion Reef	11,600	7,056
Hutti (Nizam's)	—	900
Jibutil	—	—
Mysore	23,021	12,654
North Anantapur	1,160	895
Nundydroog	8,203	6,042
Ooregum	1[illegible]750	7,245

Base Metal Outputs

		February 1919
Arizona Copper	Short tons copper	1,5[illegible]
British Broken Hill	Tons lead concentrate	2,[illegible]6[illegible]
	Tons zinc concentrate	2,060
	Tons carbonate ore	460
Broken Hill Block 10	Tons lead concentrate	1,108
	Tons zinc concentrate	1,172
Burma Corp.	Tons refined lead	1,266
	Oz. refined silver	164,000
Freemantle Trading	Long tons lead	—
North Broken Hill	Tons lead	1,[illegible]
	Oz silver	62,[illegible]
Poderosa	Tons copper ore	[illegible]
Rhodesian Broken Hill	Tons lead and zinc	[illegible]
Tanganyika	Long tons copper	1,[illegible]
Tolima	Tons silver-lead concentrate	[illegible]
Zinc Corp.	Tons zinc concentrate	6,050
	Tons lead concentrate	[illegible]

Imports of Ores and Metals into United Kingdom.

Long tons

	Jan 1919	Feb 1919	March 1919
	Tons	Tons	Tons
Iron Ore	555,264	[illegible]	413,245
Copper Ore	3,789	[illegible]	17
,, Precipitate	1,954	498	[illegible]
,, Metal	14,591	14,258	14,406
Copper and Iron Pyrite	33,942	21,873	10,146
Tin Concentrate	5,754	3,736	951
,, Metal	[illegible]	587	2,725
Manganese Ore	33,216	24,031	38,157
Lead, Pig and Sheet	25,153	26,336	23,522
Zinc Spelter	11,187	9,138	11,533
Zinc Oxide	226	5	141
Barytes	270	289	[illegible]
Rock Phosphate	70,587	27,704	[illegible]
Brimstone	5,010	—	[illegible]
Boracic Compounds	2,185	24,800	[illegible]
Nitrate of Potash	758	8,169	[illegible]
	lb	lb	lb
Quicksilver	—	—	[illegible] 116

Exports of Copper from United States

1917	Long tons	1918	Long tons	1918	Long tons
July	38,127	January	40,530	July	28,826
August	45,304	February	28,160	August	20,440
September	30,193	March	22,550	September	32,730
October	34,115	April	22,227	October	15,218
November	38,658	May	28,880	November	19,476
December	35,000	June	31,791	December	18,564
Total 1917	484,120			Total 1918	309,800

Outputs of Tin Mining Companies

In Tons of Concentrate.

	Year 1918 Tons	Feb. 1919 Tons	Year 1919 Tons
Nigeria:			
Abu	33	—	
Anglo-Continental	207	22	47
Benue	146	8	[illegible]
Berrida		1	
Bisichi	275	15	[illegible]
Bongwelli	17	5	[illegible]
Dua	60	9	18
Ex-Lands	342	28	[illegible]
Filani	37	—	4
Forum River	274	15	[illegible]
Gold Coast Consolidated	30		
Gurum River	90	12	[illegible]
Jantar	141	9	21
Jos	228	30	54
Kaduna	178		4
Kano	60	15	32
Kassa-Ropp	133	12	24
Keffi	118	6	14
Kuru	12	20	36
Kuskie	21		1
Kwall	108	—	
Lower Bisichi	90	11	[illegible]
Lucky Chance	27	3	
Minna	40		[illegible]
Mongu	476	56	100
Naraguta	478	34	68
Naraguta Extended	280	18	35
New Lafon	198	21	[illegible]
Nigerian Tin	87	7	14
N.N. Bauchi	465	20	5[illegible]
Offin River	120	8	16
Rayfield	689	72	1[illegible]
Ropp	836	98	190
Rukuba	1[illegible]	—	
South Bukeru	64	—	
Sybu	40	—	[illegible]
Tin Areas	96	6	[illegible]
Tin Fields	138	15	[illegible]
Toro	17		1
Federated Malay States:			
Chenderiang	174	—	
Gopeng	979	68	1[illegible]
Idris Hydraulic	1[illegible]6	18	[illegible]
Ipoh	245	11	[illegible]
Kamunting	276		
Kinta	478	33	[illegible]
Kledang	38		
Lahat	369	25	6[illegible]
Malayan Tin	750	53	110
Pahang	1,877	154	[illegible]
Rambutan	207	15	[illegible]
Sungei Besi	408	21	42
Tekka	508	36	88
Tekka-Taiping	400	20	61
[illegible]	1,364	113	26
[illegible]	133		
Cornwall:			
[illegible]	140		
[illegible]	787	64	123
East [illegible]	1,336	104	231
Geevor	569		
South Crofty	598	48	88
Other Countries:			
Aramayo Francke (Bolivia)	1,816		200
Briseis (Tasmania)	327	14	29
Deebook (Siam)	348	18	61
Mawchi (Burma)	658	55	123
Porco (Bolivia)	227	21	48
Renong (Siam)	615	50	89
Rooiberg Minerals (Transvaal)	335	7	70
Siamese Tin (Siam)	989	42	110
Tongkah Harbour (Siam)	1,328	76	206
Zaaiplaats (Transvaal)	—	[illegible]	138

Nigerian Tin Production.

In long tons of concentrate of unspecified content.

Note These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	588
February	469	358	528	646	668	595
March	502	418	547	655	707	
April	482	444	486	555	584	—
May	480	357	536	509	525	—
June	460	373	510	473	492	—
July	432	455	506	479	545	
August	228	438	498	551	571	
September	289	442	535	538	520	—
October	272	511	584	578	491	—
November	283	467	679	621	472	—
December	326	533	654	655	518	—
Total	4,708	5,213	6,594	6,927	6,771	1,183

Total Sales of Tin Concentrate at Redruth Ticketings

	Long tons	Value	Average
Total, 1917	4,186	£561,003	£134 0 0
January 14, 1918	141	£23,563	£167 2 3
January 28	171½	£28,976	£168 19 2
February 11	166½	£29,674	£178 4 6
February 25	156½	£28,213	£180 18
March 11	178¼	£33,398	£187 7 4
March 25	169½	£31,253	£184 7 9
April 8	157¼	£29,575	£188 1 8
April 22	159½	£31,402	£196 17 7
May 6	172½	£39,999	£232 4 4
May 21	169½	£36,791	£217 1 2
June 3	172	£36,109	£209 18 9
June 18	153	£29,692	£194 1 9
July 1	170½	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£231 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£28,793	£202 1 2
September 24	145¾	£29,639	£203 7 2
October 7	136½	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	165¾	£25,170	£150 19 0
December 16	175¼	£26,032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786,541	£192 0 0
January 13, 1919	160	£20,838	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24	142	£15,015	£105 14 10
March 10	144½	£18,123	£125 8 5
March 24	148½	£17,877	£120 7 8

Details of Redruth Tin Ticketings.

	March 10 Tons Sold	March 10 Realized per ton £ s. d	March 24 Tons Sold	March 24 Realized per ton £ s. d
E. Pool & Agar, No. 1	10	122 17 6	10	117 15 0
" No. 1a	10	120 0 0	10	117 0 0
" No. 1b	10	121 0 0	10	117 15 0
" No. 1c	10	120 0 0	10	116 10 0
Dolcoath, No. 1	8	130 7 6	9	128 15 0
No. 1a	8	131 0 0	9	129 5 0
No. 1b	8	132 0 0	9	128 7 6
No. 2	3½	62 2 6	2½	65 7 6
A	1¼	107 15 0	1¼	110 12 6
South Crofty, No. 1	10	125 15 0	10	124 12 6
" No. 1a	11	127 7 6	11	124 15 0
Grenville Utd., No. 1	9	123 10 0	9	118 12 6
" No. 1a	8	122 15 0	8	117 10 0
" No. 2	—	—	3	42 12 6
Tincroft Mines, No. 1	7	135 0 0	7	131 0 0
" No. 1a	7	135 10 0	7	129 15 0
Levant Mines	18	134 15 0	14	127 15 0
Basset Mines	8	123 17 6	5	120 10 0
Wheal Bellan	—	—	2	122 0 0
Hingston Downs	3¼	135 [illegible] 0	—	—
Porthledden	—		1½	110 15 0
Total	144½		148½	

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons. *Figures not published.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January ...	4,395	4,316	3,558	*	*
February ...	3,780	3,372	2,755		2,673
March ...	3,653	3,696	3,286	*	2,819
April ...	3,619	3,177	3,251	*	—
May ...	3,823	3,729	3,413	*	—
June ...	4,048	3,435	3,489	*	—
July ...	3,544	3,517	*	*	—
August	4,046	3,732	*	*	—
September .	3,932	3,636	*	*	—
October. . .	3,797	3,681	*	*	—
November .	4,059	3,635	*	*	—
December .	4,071	3,945	*	*	—
	46,767	43,871	39,833	37,370	—

STOCKS OF TIN

Reported by A. Strauss & Co. Long Tons.

	Feb. 28, 1919	March 1919
	Tons	Tons
Straits and Australian Spot ...	1,113	1,063
Ditto, Landing and in Transit	—	1,949
Other Standard, Spot and Landing ...	824	604
Straits, Afloat	2,618	1,230
Australian, Afloat	300	405
Banca, on Warrants	—	—
Ditto, Afloat	—	—
Billiton, Spot		—
Billiton, Afloat	—	—
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	—	1,024
Total Afloat for United States	1,875	
Stock in America	251	156
Total	6,981	6,431

SHIPMENTS, IMPORTS, SUPPLY AND CONSUMPTION OF TIN

Reported by A. Strauss & Co. Long tons.

	Feb 1919	March 1919
	Tons	Tons
Shipments from		
Straits to U.K.	618	1,230
Straits to America	240	—
Straits to Continent	2	1,024
Australia to U.K.	—	300
U.K. to America	—	—
Imports of Bolivian Tin into Europe	510	—
Supply:		
Straits	2,860	2,254
Australian	200	100
Billiton	75	—
Banca	593	—
Standard	492	409
Consumption:		
U.K. Deliveries	1,296	1,448
Dutch „	20	45
American „	2,450	2,070
Straits, Banca & Billiton, Continental Ports, etc.	1,173	618
Total	4,939	4,181

PRICES OF CHEMICALS. April 10

		£	s.	d.
Alum	per ton	17	0	0
Alumina, Sulphate of	„	19	0	0
Ammonia, Anhydrous	per lb.		1	10
„ 0·880 solution	per ton	34	0	0
„ Carbonate	per lb.			6
„ Chloride of, grey	per ton	50	0	0
„ „ „ pure	per cwt.	4	0	0
„ Nitrate of	per ton	70	0	0
„ Phosphate of	„	120	0	0
„ Sulphate of	„	17	10	0
Antimony Sulphide	per lb.		1	3
Arsenic, White	per ton	36	0	0
Barium Sulphate	„	12	0	0
Bisulphide of Carbon	„	46	0	0
Bleaching Powder, 35% Cl.	„	15	0	0
Borax	„	39	0	0
Copper, Sulphate of	„	47	0	0
Cyanide of Sodium, 100%	per lb.			10
Hydrofluoric Acid	„			7
Iodine	„		14	0
Iron, Sulphate of	per ton	6	0	0
Lead, Acetate of, white	„	95	0	0
„ Nitrate of	„	65	0	0
„ Oxide of, Litharge	„	48	0	0
„ White	„	55	0	0
Lime, Acetate, brown	„	15	0	0
„ „ grey 80%	„	25	10	0
Magnesite, Calcined	„	30	0	0
Magnesium Chloride	„	16	0	0
„ Sulphate	„	11	0	0
Methylated Spirit 64° Industrial	per gal		8	7
Phosphoric Acid	per lb.		1	8
Phosphorus, yellow	„		1	10
Potassium Bichromate	„		2	[illegible]
„ Carbonate	per ton	105	0	0
„ Chlorate	per lb.		1	4
„ Chloride 80%	per ton	57	10	0
„ Hydrate, (Caustic) 90%	„	260	0	0
„ Nitrate	„	60	0	0
„ Permanganate	per lb.		8	0
„ Prussiate, Yellow	„		2	0
„ Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	3
„ Acetate	per ton	75	0	0
„ Arsenate 45%	„	40	0	
„ Bicarbonate	„	9	10	0
„ Bichromate	per lb.		1	[illegible]
„ Carbonate (Soda Ash)	per ton	1[illegible]	0	0
„ „ (Crystals)	„	4	5	0
„ Chlorate	per lb.			10
„ Hydrate, 76%	per ton	24	10	0
„ Hyposulphite	„	17	0	0
„ Nitrate, 95%	„	20	0	0
„ Phosphate	„	28	0	0
„ Prussiate	per lb.			9
„ Silicate	per ton	12	0	0
„ Sulphate (Salt-cake)	„	3	0	0
„ „ (Glauber's Salts)	„	3	10	0
„ Sulphide	„	26	0	0
Sulphur, Roll	„	22	0	0
„ Flowers	„	28	10	0
Sulphuric Acid, Non-Arsenical 140°T.	„	5	0	0
„ „ „ 90%	„	7	5	3
„ „ „ 96%	„	9	7	6
Superphosphate of Lime, 18%	„	5	0	0
Tartaric Acid	per lb.		3	5
Zinc Chloride	per ton	23	0	0
Zinc Sulphate	„	23	0	0

4—

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	April 5, 1918 £ s. d.	April 4, 1919 £ s. d.
RAND		
Bantjes	3 6	3 0
Brakpan	4 15 0	3 12 6
Central Mining (£8)	8 17 6	8 0 0
Cinderella	4 0	6 0
City & Suburban (£4)	17 6	11 0
City Deep	2 16 6	2 11 3
Consolidated Gold Fields	1 15 0	1 15 9
Consolidated Langlaagte	16 6	18 0
Consolidated Main Reef	15 6	14 0
Consolidated Mines Selection (10s).	1 11 0	1 8 6
Crown Mines (10s.)	1 10 0	2 2 6
Daggafontein	1 7 0	1 8 3
D. Roodepoort Deep	10 0	8 6
East Rand Proprietary	5 0	5 6
Ferreira Deep	13 9	12 6
Geduld	1 18 9	2 7 6
Geldenhuis Deep	13 9	11 [illegible]
Gov't Gold Mining Areas	3 11 3	4 13 9
Heriot	1 7 6	16 3
Jupiter	5 0	5 [illegible]
Kleinfontein	19 0	13 3
Knight Central	4 0	7 9
Knight's Deep	9 6	8 0
Langlaagte Estate	13 6	18 6
Meyer & Charlton	4 18 [illegible]	4 8 9
Modderfontein (£4)	22 10 0	[illegible] 10 [illegible]
Modderfontein B	7 7 6	8 2 [illegible]
Modder Deep	7 1 3	7 8 9
Nourse	18 [illegible]	14 6
Rand Mines (5s.)	2 11 3	[illegible] 18 0
Rand Selection Corporation	4 10 0	4 10 0
Randfontein Central	11 6	13 6
Robinson (£5)	15 6	13 [illegible]
Robinson Deep A (1s.)	1 1 3	17 6
Rose Deep	18 0	15 0
Simmer & Jack	5 0	4 0
Simmer Deep	3 0	[illegible]
Springs	3 13 9	3 5 [illegible]
Sub Nigel	1 5 6	1 8 9
Van Ryn	1 0 0	16 [illegible]
Van Ryn Deep	3 9 6	3 10 0
Village Deep	19 6	15 6
Village Main Reef	12 0	1 0
Witwatersrand (Knight's)	1 6 3	1 1 3
Witwatersrand Deep	8 0	13 6
Wolhuter	[illegible] 6	4 [illegible]
OTHER TRANSVAAL GOLD MINES		
Glynn's Lydenburg	18 9	1 2 6
Sheba (5s.)	9	1 0
Transvaal Gold Mining Estates	17 0	13 6
DIAMONDS IN SOUTH AFRICA:		
De Beers Deferred (£2 10s.)	12 12 6	19 17 6
Jagersfontein	4 6 3	4 17 6
Premier Deferred (2s. 6d.)	7 0 0	7 2 6
RHODESIA		
Cam & Motor	11 0	[illegible]
Chartered British South Africa	15 0	1 0 6
Eldorado	6 6	4 6
Falcon	1 2 0	13 0
Gaika	15 0	16 6
Giant	7 6	7 9
Globe & Phoenix (5s.)	1 10 6	1 11 6
[illegible] Reef	1 12 6	1 18 0
[illegible]	4 0 0	4 17 6
[illegible]	1 12 6	2 0 0
[illegible]	1 6	1 0
[illegible]	5 0	6 [illegible]
W[illegible]		
A[illegible]	4 0	4 6
A[illegible]	7 6	6 3
Ashanti ([illegible]	1 [illegible] 0	1 1 6
Prestea Block A	[illegible]	4 6
Taquah	16 0	13 6
WEST AUSTRALIA		
Associated Gold Mines	[illegible] 6	4 3
Associated Northern Blocks	2 6	4 3
Bullfinch	[illegible] 0	1 9
Golden Horse-Shoe (£5)	[illegible]	1 15 0
Great Boulder Proprietary (2s.)	[illegible] 3	11 6
Great Fingall (10s).	1 9	2 3
Ivanhoe (£5)	1 15 0	1 18 9
Kalgurli	9 0	13 0
Sons of Gwalia	9 3	8 0

GOLD, SILVER, *cont.*	April 5, 1918 £ s. d.	April 4, 1919 £ s. d.
OTHERS IN AUSTRALASIA		
Mount Boppy, New South Wales	7 6	3 9
Talisman, New Zealand	15 0	12 6
Waihi, New Zealand	1 16 0	2 0 0
Waihi Grand Junction, New Z'lnd	17 0	14 6
AMERICA		
Alaska Treadwell (£5), Alaska	—	2 0 0
Buena Tierra, Mexico	12 6	1 1 0
Camp Bird, Colorado	8 6	19 3
Casey Cobalt, Ontario	9 3	4 0
El Oro, Mexico	9 0	16 6
Esperanza, Mexico	9 9	15 6
Frontino & Bolivia, Colombia	12 6	11 3
Le Roi No. 2 (£5), British Columbia	7 0	9 0
Mexico Mines of El Oro, Mexico	5 5 0	6 12 6
Oroville Dredging, California	18 6	1 2 0
Plymouth Consolidated, California	1 2 6	1 2 6
St. John del Rey, Brazil	16 9	17 0
Santa Gertrudis, Mexico	13 3	1 4 3
Tomboy, Colorado	17 6	14 0
RUSSIA:		
Lena Goldfields	1 5 0	1 12 6
Orsk Priority	13 9	15 0
INDIA		
Balaghat	4 0	4 0
Champion Reef (2s. 6d.)	5 3	4 3
Mysore (10s.)	2 16 3	2 2 0
North Anantapur	4 9	3 0
Nundydroog (10s.)	1 4 0	19 0
Ooregum (10s.)	18 9	17 0
COPPER:		
Arizona Copper (5s.), Arizona	2 7 6	1 16 3
Cape Copper (£2), Cape Province	2 15 0	2 7 6
Chillagoe (10s.), Queensland	1 0	1 6
Cordoba (5s.), Spain	2 0	2 3
Great Cobar (£5), N.S.W.	2 0	1 6
Hampden Cloncurry, Queensland	1 8 0	1 0 0
Kyshtim, Russia	17 6	1 12 6
Messina (5s.), Transvaal	8 0	5 0
Mount Elliott (£5), Queensland	3 10 0	3 10 0
Mount Lyell, Tasmania	1 8 0	1 3 9
Mount Morgan, Queensland	1 12 0	1 4 6
Namaqua (£2), Cape Province	2 2 6	1 17 6
Rio Tinto (£5), Spain	64 0 0	56 0 0
Sissert, Russia	17 6	18 9
Spassky, Russia	1 0 0	1 10 0
Tanalyk, Russia	17 6	1 18 9
Tanganyika, Congo and Rhodesia	3 3 9	4 10 0
Tharsis (£2), Spain	6 10 0	5 15 0
LEAD-ZINC:		
BROKEN HILL:		
Amalgamated Zinc	1 9 6	1 12 6
British Broken Hill	2 1 0	2 3 6
Broken Hill Proprietary (8s.)	3 8 6	2 8 0
Broken Hill Block 10 (£10)	1 15 6	1 10 0
Broken Hill North	2 19 6	2 18 0
Broken Hill South	10 5 0	2 17 6*
Sulphide Corporation (15s.)	1 7 0	1 5 0
Zinc Corporation (10s.)	1 0 0	1 5 0
ASIA		
Burma Corporation	4 5 0	6 5 0
Irtysh Corporation	19 6	1 13 9
Russian Mining	10 0	17 6
Russo Asiatic	2 5 0	3 12 6
TIN:		
Aramayo Francke, Bolivia	1 17 6	3 5 0
Bisichi Nigeria	15 3	13 6
Briseis Tasmania	5 6	5 0
Dolcoath, Cornwall	11 6	8 0
E[illegible] Cornwall	1 12 3	1 5 6
Ex-Lands Nigeria (2s.), Nigeria	2 6	2 9
Gee[illegible]s.) Cornwall	1 3 6	15 6
Gopeng, Malay	1 17 6	2 3 9
Ipoh Dredging, Malay	16 6	1 2 0
Malayan Tin Dredging, Malay	2 2 6	2 3 9
Mongu (10s.), Nigeria	16 6	16 0
Naraguta, Nigeria	17 6	17 6
N. N. Bauchi Pref. (10s.), Nigeria	12 9	8 3
Ord. (10s.)	12 9	12 [illegible]
Pahang Consolidated (5s.), Malay.	12 9	15 [illegible]
Rayfield, Nigeria	13 6	14 6
Renong Dredging, Siam	2 5 6	1 17 6
Ropp (4s.), Nigeria	1 2 0	1 1 6
Siamese Tin, Siam	3 1 3	3 1 3
South Crofty (5s.), Cornwall	2 9 6	2 0 0
Tekka, Malay	3 12 6	3 15 0
Tekka Taiping, Malay	3 15 0	3 17 6
Tronoh, Malay	1 13 9	1 18 9

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

METALLURGY OF TUNGSTEN.

In the *Journal of Industrial and Engineering Chemistry* for March, C. W. Davis, of Golden, Colorado, gives some useful information relating to the reduction of tungstic oxide to powdered metallic tungsten, founded on his own investigations.

Tungstic acid, as it comes from the filter-press after its precipitation with acid, contains considerable water. When air-dried, there is still over 7% total water in the material. This must be removed before reduction, for the steam that would be liberated during the heating would cause the material to fly in all directions, thus tending to separate the tungstic oxide from the reducing material, when carbon in some form is used, due to the great difference in their specific gravities. Even when dried in a current of air at 100°C., 3·7% total water remains. To get a sufficiently dry product, the material must be dried in a current of air at about 500°C. This may be done in either reverberatory or revolving furnaces. For all reduction experiments, the tungstic oxide was thoroughly dried at 500°C., the colour changing from a pure yellow to a greenish yellow.

For a satisfactory reduction, the dried tungstic oxide must be in a state of fine division, and if reduced with some form of carbon, should be completely mixed with it. The most satisfactory treatment consists of grinding together the tungstic oxide and the carbon in a tube-mill. Steel or wooden balls should be used, for porcelain or flint introduces more impurities. The purpose to which the finished product is to be put, however, determines the permissible impurities. When the tungsten powder is to be added to molten steel for the manufacture of tungsten steel, traces of iron or manganese are not injurious, and silica goes into the slag.

It is well to use some form of binding material when preparing this mix for reduction. Since the specific gravities of tungstic oxide and carbon are so different, their segregation during the processes of reduction is quite apt to occur. Colophonium, being itself a good reducing agent, easily obtained in a pure condition, and easily pulverized, is to be recommended. The quantity of this material used by different operators varies from 10 to 30% of the carbon requirement of the reduction.

The tungsten oxide used in the experiments was an impalpable, canary-yellow powder. As received, the tungstic acid gave off 8·3% of water at a temperature of 500°C. Analysis of the tungstic oxide, dried at 500°C., showed a tungstic oxide content of 99·4%, insoluble in potassium hydroxide, 0·55%, largely silica.

The reduction processes used are conveniently divided into two sections, that of using some form of solid carbon being the more common, while the reduction performed by some reducing gas gives a purer product. In both cases, the reduced material must be cooled in a reducing atmosphere as the powdered tungsten readily oxidizes when heated. The oxidation, once started, is pyrophoric in action, and is incandescent after the removal of the source of heat.

The temperature necessary for the reduction of tungstic oxide to the metal, using some form of carbon, is given variously, ranging all the way from red heat up to the temperature obtained with the electric furnace. The author's tests indicated that at a temperature of 650° to 850°C. the reduction produces a blue or purple oxide; at a temperature of 900° to 1050°C. the reduction produces a chocolate-brown material, a mixture of oxides; at a temperature above 1050°C. a grey product is obtained which is undoubtedly metallic tungsten. Other tests indicated that the carbon content necessary for adequate reduction depended both on the temperature of reduction and the resulting time required, the ratio being about 10 parts tungstic oxide to 1·4 parts carbon.

Other results are given as follows: Excess carbon can be partly removed by washing. Fire-clay crucibles or iron tubes give satisfactory reduction with a product of over 98% tungsten; under the conditions of the test some oxides resulted at portions nearest the crucible cover and tube ends. Fire-clay is not attacked by the charge at the temperature used; the iron tubes suffer considerable oxidation on the outside.

In the tests there was always some material which was not completely reduced. Although this material could be used again in the next charge, it was thought advisable to try a continuous process where there would be no material left in an oxidized condition, and where the reduced material would be cooled without cooling the container, which would remain at the temperature required for reduction. The apparatus consisted of a 1 in. pipe, 3 ft. long, set at a slant in a furnace so that a portion 9 in. long was kept at a temperature of about 1,080°C. The mixture of tungstic oxide and carbon was of the ratio 10 to 1·5. This mixture was fed in at the top end of the tube, and from time to time was poked through, so that the material was in the hot portion about 30 in. The reduced material would then be forced into the cooled part of the tube, cooled by water. From time to time the reduced material was removed from the cold end of the tube. The product was quite dark or black. The first portion, however, was grey and lumpy. This dark portion analysed: tungsten 95·2%, carbon 4·4%. The dark colour is thus seen to be due to excess carbon. The reducing action of the gases which come from the heated mass and pass through the tungstic oxide mixture plays an important part, as evidenced by the first reduction product being grey. That is, the first part of the charge, having no reducing gases passing through it, was properly regulated with respect to the tungstic oxide and carbon ratio. On the other hand, the later charges, being partly reduced with gas, had an excess of carbon. Although the carbon in this run was excessive, it could be easily regulated by reducing the carbon in the mix. The material was washed with water and showed 98·5% tungsten. The washing as performed consisted of a crude panning, so that better results could be expected by a jig or table treatment. The possible advantages of using

...tinuous process such as the one suggested would be: Less heat loss, due to keeping the apparatus at a constant temperature; no unreduced oxides of tungsten; small chance of air coming in contact with the hot charge, and less wear and tear on the apparatus, since the greatest deterioration occurs on heating and cooling.

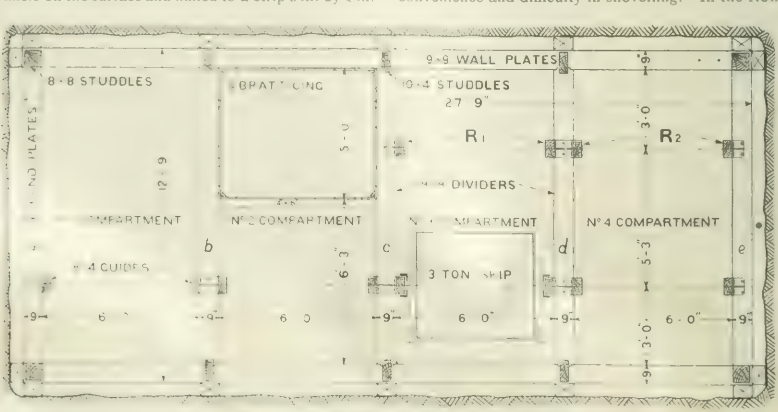
As regards reduction by gas, various authorities have stated that tungstic oxide is reduced to metal by pure dry hydrogen at temperatures from 600° to 1,000°C. From these statements the author was led to believe that the reduction temperature with gas at ordinary pressures might be lower than that required when carbon was used. This would cause less difficulty in maintaining the temperature and would save considerably on the wear and tear of the apparatus. Experiments were conducted to determine the temperature required for reduction with hydrogen, and it was found that reduction with hydrogen at ordinary pressures is not noticeably different from that with carbon. It may be that long heating with large excess of hydrogen would reduce the oxide at lower temperatures. This treatment, however, is hardly applicable if the reduction process is to be used commercially. However, at temperatures over 1,050°C. the reduction proceeds quickly and the product is a very pure tungsten powder. Producer gas might well be used in place of hydrogen for the reduction.

"SQUARE" SHAFTS ON THE RAND.

At the January meeting of the South African Institution of Engineers, the subject of discussion was the best form for deep vertical shafts on the Rand. Mr C. E. Knecht, of the Consolidated Mines Selection, gave his reasons for adopting the long rectangular shaft at West Springs and Daggafontein; Mr. H Stuart Martin, of the Central Mining group, argued in favour of circular shafts; and Mr. W. L. White, of the Barnato group, described the "square" shaft adopted at Randfontein Central and New State Areas. The word "square" is used in default of anything better, and indicates a rectangular shaft not so narrow and long as the usual 7-compartment shaft. We give extracts here from Mr. White's paper, and intend to quote the other two papers in a subsequent issue.

The vertical shafts recently started at Randfontein and at the New State Areas, there being two at each mine, are of a shape which is quite a novelty for South Africa. The size of the excavation at Randfontein is 28 ft. 9 in. by 13 ft. 1 in., and at the New State Areas 28 ft. 9 in. by 13 ft. 9 in.; in both cases allowing 6 in. for blocking. The compartments are 6 ft. within by 10 ft. 7 in. at Randfontein, and 11 ft. 3 in. at the New State Areas. The bratticed compartment is 6 ft. by 4 ft. at Randfontein, and 6 ft. by 5 ft. at the New State Areas. The bratticing consists of tongued and grooved flooring boards, put together in panels on the surface and nailed to a strip 3 in. by ¾ in. The panels are nailed to the shaft timbers, and corner pieces are provided. The ventilation compartment communicates with a duct leading under the bank to a fan of from 30,000 to 40,000 cubic feet per minute capacity, this fan being situated at some convenient spot. In compartments 1 and 2 there are two pairs of runners; in compartments 3 and 4 there are four pairs of runners. These runners are all of 8 in. by 4 in. section, and are fastened to the dividers by two bolts through cast-iron chairs, the chairs being fastened to the dividers by two ⅝ in bolts. The wall plates, end plates, and dividers are all of 9 in. section. The cross-piece carrying one side of the bratticed compartment is of 4 in. by 6 in. section. Corner studdles are 8 in square; middle studdles 10 in. by 4 in., with 3 in. lap over the dividers. Bearer sets are put in every 140 ft.; five pieces of 8 in. by 8 in. under *a* and *b*, and three pieces under *d* and *e*, the number at *a* and *b* being increased to take the weight of air and water columns. The dividers are dapped in 1½ in. at each end. The area of the clear space, including the air duct, is 248 sq. ft. at Randfontein, and 264 sq. ft. at the New State Areas; so that at 1,000 ft. per minute these shafts will downcast 248,000 and 264,000 cu. ft. of air per minute respectively.

With the older style of five-compartment and seven-compartment shafts, during sinking there is great inconvenience and difficulty in shovelling. In the New



CROSS-SECTION OF SHAFTS AT NEW STATE AREAS

State Areas shaft the tipping horn is put behind the skip guides, and the front side is open for shovelling. With the old type of skip practically all the rock had to be shovelled over the two sides, which were made still more inconvenient by reason of the position of the horn and the smallness of the spaces that were open for shovelling. The skip stood 4 ft. high when resting on the broken rock, and carried two tons. In the new shape the skip is open for shovelling practically on three sides, stands 4 ft. 1 in. high, and carries 3 tons. This explains why the width of the compartments was increased to 6 ft. within as against 5 ft. within in the older shape.

Each of the eight engines on these shafts is direct-acting, and capable of speeds from 1,900 ft. to 2,350 ft per minute. The principal engine on each shaft serves Nos. 2 and 3 compartments, and hoists practically all the rock. The second engine serves Nos. 1 and 4 compartments, and is the timbermen's hoist. It may hoist rock to some extent, but—unless the blasts are very heavy indeed—it is found most convenient to hoist all the rock with the two skips in the middle of the shaft.

The two pairs of runners shown as R_1 and R_2 are intended for balers if very heavy water is met with during sinking, and it becomes necessary to erect a third engine.

The bratticed compartment is a result of the difficulties experienced in increasing the amount of fresh air entering the workings of the Government Gold Mining Areas previous to any connection being made between the shafts. In these shafts the end compartment was bratticed off by boards placed horizontally and scribed to the rock faces. Without fans these compartments were upcasting about 4,000 cu. ft. per minute; with fans it was found that, although the fan was drawing perhaps 20,000 cu. ft., the actual amount of fresh air was only increased to about 6,000 cu. ft. The cement gun would probably overcome this difficulty at some expense, but at that time it was found impossible to make the joints between the deals and rock faces sufficiently tight to get more than 6,000 cu. ft. of fresh air into the workings. This point was a very important one, and by using tongued and grooved flooring boards, and fastening to the timbers as described, it is hoped to provide these mines during development, and before connection has been made, with ample quantities of fresh air, with corresponding effect on the health of the workers and efficiency of the work. The point is specially important where, as in the case of the Far East Rand, long distances have to be driven, and double shift work is necessary in order to bring a mine rapidly to the producing stage.

The last point to draw attention to is the provision of long cage compartments with four runners in each. The amount of time consumed in man-handling work and steel is very great on these fields, and although arrangements can be made to sling special trollies under the skips in narrow shafts, the simplest and most expeditious way is to run trucks of timber, steel, and other stores straight into the cage, which is of sufficient length to take all jumpers and practically all timber when piled horizontally in trucks. Efficient and expeditious use of hoisting engines means a corresponding reduction in size of engines and saving of capital. Thus, the hoisting equipment on the New State Areas consists of two engines pulling a four-ton net load, and two engines pulling a three-ton net load. The two shafts at this mine will be connected by a haulage underground, and these engines will serve the property up to a capacity of 150,000 tons per month. Both engines would handle natives and white men at the beginning and end of the shift; and allowing four hours for this work, and inspection in the case of each hoist, six hours for drills and timber in the case of the second hoist, the main hoist would be hoisting rock for twenty hours, and the second hoist for fourteen hours. This would give a total capacity of 78,000 tons per month for each shaft from a depth of 3,800 feet.

As regards strength of the timbers, with the increase of the dividers from 7 in. by 9 in. to 9 in. by 9 in., this shape of shaft timbering is as strong, speaking generally, as the seven-compartment. This is not the case as regards the end plates when considered as beams, but these members could easily be strengthened to any desired extent in specially bad ground.

The strongest natural shape for a shaft is undoubtedly the circular, and next to this the elliptical; and, in a general way, it is clear that a rectangular excavation of 29 ft. by 14 ft. must be a stronger excavation than one of a dimension of 45 ft. by 11 ft.

Mr. White then explained the reasons why in the circumstances with which he was faced he decided against both the circular type and the seven-compartment type of shafts. He began by giving eight points of comparison with the circular shaft.

(*1*) The determining reason was the much greater certainty of getting these shafts down in reasonable time, having regard to the fact that considerable quantities of water would probably be encountered. The three winders provided for each shaft may be considered as so many pumps of such flexibility that they will draw water from 500 ft. or 5,000 ft., as the case may be. It is estimated that if the third engine be erected five balers could be used, capable of handling 2,250,000 gallons per 24 hours, from a depth of 1,500 ft., and still leaving one skip to sink with. In a round shaft without pumps about 12 buckets of water per hour, making 108,000 gallons per day, is about the limit of the engine from, say, 1,500 ft.; and it will be less as one gets deeper. In the case of round shafts, pump chambers have to be cut every 500 ft. and sinking pumps used in the bottom. In a 5,000 ft. shaft, ten pump chambers would be necessary, and, even if only small quantities of water were cut throughout the sinking, ten pump installations made. In the Randfontein shafts any quantity of water up to 500,000 gallons per day would not too seriously impede the sinking. None of the round shafts completed on the Rand have had any water to speak of, and it would be interesting to see the sinking costs of a round shaft that had, say, 200,000 gallons per day throughout; in Mr. White's opinion they would not compare with the wide rectangular shaft for costs, to say nothing of the delays incidental to equipping pump chambers at every 500 ft. It was recently reported that three of the round shafts being sunk on the Far East Rand were stopped on account of water.

(*2*) Each one of the four shafts at Randfontein and New State Areas will be downcast and not upcast.

(*3*) Galloway stages at depths in circular shafts are somewhat unstable by reason of the spring in the ropes holding them; the difficulty would be exaggerated at 4,000 and 5,000 ft.

(*4*) The ventilation pipe of 22 in. diameter is not so satisfactory during sinking as the 5 ft. by 6 ft. bratticed compartment. When it comes to development, the advantage of the wide rectangular shape is more marked.

(*5*) For fast hoisting from great depths, the skip rigidly held by runners appears to be safer and preferable to hoisting with a central bucket; certainly it should give faster sinking, thus resulting in cheaper sinking, whatever may be the comparative costs at more shallow depths

(6) In round shafts little sinking is possible until all the main sinking plant is erected. At Randfontein the North Shaft was sunk 473 ft., and the South Shaft 1,000 ft., with temporary gears, and while the permanent sinking plant was being erected. This was a very important point at Randfontein, where the new shafts are most urgently required.

(7) In shovelling rock it must be conceded that the round shaft has the pull, and in the shafts under discussion an attempt has been made to incorporate to some extent this point by a bigger skip, standing lower in the shaft, and with three sides effectively open for shovelling over. In hoisting facilities the rectangular is ahead, when depths of over 3,000 ft. are reached. Taking hoisting and shovelling together, it seems clear that the wide rectangular shaft is somewhat better suited for great depths than the circular type.

(8) In breaking, the number of holes required in the circular form is greater than in the rectangular, due to the fact that in a 20 ft. round shaft about 30 holes are required round the circumference, taking the distance apart of these holes at 1 ft. 9 in., and, say, a further twenty to thirty holes for the centre of the shaft. In the rectangular on Randfontein from 40 to 45 holes altogether per shift are usually enough to bring a 2 ft. 6 in. round.

As compared with the seven-compartment shaft, Mr. White made two points: (1) The four seven compartment shafts on the Government Gold Mining Areas were sunk for an average total cost of £32. 11s. 6d. per foot. Timber cost 3s. 6d. per cubic foot. At Randfontein the shafts up to the end of November averaged £30. 6s. 6d. per foot, timber costing 7s. 9d. to 8s. per cubic foot. With timber at 3s. 6d. per cube, the average cost would have been £26. 1s. 6d. per foot. There are other charges incidental to the war, which may be overlooked. There is also the fact that the flat dip, about 12°, on the Government Gold Mining Areas is a considerable help in sinking. Taking all factors into consideration, Mr. White is inclined to think that under similar conditions the wide rectangular shaft will come out from £5 to £10 per foot cheaper than the seven-compartment of equal area. The New State Areas shafts may be fairly compared with the Government Gold Mining Areas shafts, and it will be interesting to see how the comparison works out when figures are available.

(2) In the long cage compartment, the bratticed ventilation compartment, the freer passage for air generally after connection, and greater adaptability to the elliptical form in case of need, there are further advantages.

Mr White said he was not an advocate of one type of shaft for all conditions. The very essence of mining is adaptation to conditions as they exist. In the present notes he had merely tried to give the reasons why the wide rectangular form of shaft was adopted in the conditions that existed.

MAGNESITE, ITS OCCURRENCE AND USES

(*Continued from the March issue, page 179*).

We continue our reprint of Mr. Crook's paper on Magnesite, read at the Swansea meeting of the Ceramic Society.

COMPACT MAGNESITE.—This type of magnesite usually occurs in the form of veins traversing peridotite rocks, or the serpentines which have been formed from these rocks by hydration. The crystallization is very imperfect. The constituent granules or particles are microscopically small, and the material appears to consist in part of a non crystalline paste. This texture is of the kind named cryptocrystalline by petrologists. The physical condition of compact magnesite is largely bound up with the condition of the silica, which appears to be always present, though in varying amounts, and which may be in the form of crystalline or non-crystalline magnesium silicate, or in the form of free silica, usually quartz. Geological age is probably an important factor in connection with the mineral condition of the silica, and therefore with the physical properties of this type of magnesite. Some compact magnesites, such as those of Elba in Italy, Bissel in California, and other places, readily form a paste with water, and this is probably due to the presence of colloidal matter in the form of magnesium silicate, or silica, or perhaps even hydro magnesite, which takes up water and causes the material to fall to pieces when wetted. In this respect such magnesite invites comparison with common clay. When geologically young, and unaffected by the compacting process which becomes accentuated with geological age, common clay is plastic and makes a paste with water; but when geologically old or metamorphosed it passes over into the non-plastic forms of shale, mudstone, or slate. Only the geologically young cryptocrystalline magnesites are likely to contain colloidal silica or magnesium silicate or possibly hydromagnesite, and when this is considerable in amount and not too dessicated, the magnesite will yield a paste with water. This colloidal matter is unstable and tends to break up into magnesite and crystalline silica as age advances, or perhaps to reproduce olivine and serpentine as the result of further metamorphism. It may be suggested that the presence of colloidal silicious matter at the time of deposition of the compact magnesite is probably the explanation of the texture of this kind of magnesite. Such colloidal matter has an inhibiting effect on crystallization.

The chief deposits of compact magnesite are those of Greece, California, India, Australia, South Africa, and Italy. We omit Mr. Crook's description of the Californian deposits, as accounts have been recently published elsewhere.

Greece.—The best-known and hitherto the most productive of the world's deposits of compact magnesite are those of the island of Eubœa in Greece. These deposits were described in detail a few years ago by J. Hogg (*Trans. Inst. Min. Eng.*, 1913-14). The Anglo Greek Magnesite Company issued a report dated June, 1918, dealing with the Grecian industry.

Most of the deposits so far exploited in Eubœa lie in the northern part of the island, where there is a belt of serpentine 6 to 9 miles in width and 15 miles in length. This serpentine belt is bounded on the east and west by the sea, and on the north and south by Cretaceous limestone. The magnesite occurs as white compact masses in the form of veins, lenticles, or irregular masses in the serpentine. The dimensions of the magnesite bodies are very variable. The width of the bodies varies from 6½ ft. up to 130 ft., and the greatest length so far observed in a vein is 500 ft. The greatest depth at which the deposits are worked is about 660 ft., which depth has been reached in the Mantudi mine on the north-east coast of the island. The average depth of mining operations elsewhere does not exceed 200 ft. Hogg thinks that the veins are not likely to extend to any great depth. At the mine where he was stationed a depth of 200 ft. had been reached. He observed that the vein continued in depth beyond this level, but that it was much narrower than it had been at shallower levels, while a number of veins worked at adjacent mines pinched out at a comparatively shallow depth

The more important of the Eubœan magnesite deposits may be classed in three groups. But these deposits are not all being worked at the present time, as war-time conditions have restricted transport facilities, and the output is disposed of under the control of the British and French Governments. These groups are: (1) The Limni-Galataki group, on the side of the serpentine belt; (2) The Mantudi-Pyli group, situated on the north-eastern coast of the island; and (3) The Chalcis group, situated east-south-east of Chalcis. The deposits were formerly worked by open-cut, but in recent years underground mining has been resorted to. At first instance the method adopted underground was to work the veins by wide stalls, pillars being left to support the roof, but this has more recently given place to the long-wall method of working.

The crude magnesite is hand-dressed by girls, as much serpentine and calcite as possible being eliminated in this way. The hand-dressed material is then transported to the ports of shipment, where part of it is calcined. The material to be calcined is, however, still further dressed and broken into lumps of convenient size before it is fed into the kilns. The material is shipped partly in the raw and partly calcined.

The following analyses show the chemical composition of typical samples of Grecian raw magnesite:

	Typical Raw Grecian	Mantudi (a)	Mantudi (b)	Macedon	Kymi
	%	%	%	%	%
Magnesium carbonate	95·70	98·08	97·45	94·10 to 98·70	92·05
Calcium carbonate ...	2·20	0·80	1·39	Trace .. 3·00	6·15
Silica	1·48	0·30	0·20	0·16 .. 4·00	1·30
Ferric oxide and alumina	0·60	1·20	1·15	0·02 .. 0·40	0·50

The kilns used in Greece are large gas-fired bottle kilns, and up to recent years these were all of the Schmatolla type. In a few years various improvements, including Morgan gas generators, and pressure and exhaust fans, have been introduced, the result being to increase the rate of calcination and reduce the consumption of fuel. Experiments have been made with a rotary kiln of the Fellner & Ziegler type, but this kiln has not hitherto met with great success.

Three kinds of magnesia are produced in the Grecian kilns, caustic, hard-burnt, and dead-burnt. Hard burnt is over-burnt caustic, but it is specially produced in some cases and finds a use in the manufacture of magnesia bricks. The following analyses show the composition of typical samples of these different kinds of magnesia obtained by calcination:

	Caustic	Hard burnt	Dead-burnt
	%	%	
Magnesia	91·00	[illegible]	[illegible]
Lime	2·50	[illegible]	4·10
Ferric oxide and alumina	2·55	1·46	1·57
Silica	2·55	2·67	3·00
Moisture	1·10	1·30	0·71

The production of caustic magnesia requires on the average 4·8 cwt. of coal per ton of caustic magnesia produced, while in the old type of bottle kiln dead-burning or sintering requires from 6 to 7 cwt. per ton of sintered magnesia produced. The latest type of sintering kiln requires about 4·6 cwt. of coal per ton of sintered magnesia produced. The Anglo-Greek Company uses imported coal in their kilns, but they are making experiments with brown coal, which they are mining locally. The brown coal of Eubœa is stated to be of good quality. The Société Financière de Grèce is mining this Eubœan brown coal at Koumi, and using it in their kilns for calcining magnesite.

India.—The magnesite deposits that have been worked in India, chiefly in the chalk hills of the Salem district of the Madras Presidency, and to a comparatively small extent in Mysore, are of the cryptocystalline vein type. The total production of magnesite in India during 1916 was 17,640 tons, of which 17,540 tons was raised in the Salem district and only 100 tons in Mysore. The deposits of the "chalk" hills were described in 1862 by W. King and R. Bruce Foote in their account of the geology of the Salem district, and later by C. S. Middlemiss. Both of these descriptions were published by the Geological Survey of India. These hills are situated some four or five miles to the north and north-west of the town of Salem, in Southern India. The Madras railway runs within a mile or so of the deposits, but the distance from the port is unfortunately long, the deposits being some 200 miles from Madras and about the same distance from Beypur. The chalk hills received their name from the chalk-like appearance of the veins of magnesite, which stand out boldly and make a conspicuous feature on their bare surfaces. According to Middlemiss, the hills comprise two areas of about 1¼ and 3½ square miles. The rock of the hills consisted of serpentinized peridotite, which is intrusive in gneisses, occupying the surrounding plain. The serpentine is veined irregularly with magnesite. Middlemiss estimated that magnesite constituted from a third to a half of the total volume of the rock over an area of 620,000 square yards, and about a tenth to a sixth over an area of 5,536,000 square yards. The richest portions of the deposits seen at the surface form hillocks rising to various heights, up to 140 ft. above the plain, so that an almost unlimited supply is available by means of quarrying. Messrs. King and Bruce Foote report the presence of films and thin veins of fibrous serpentine, chalcedony, and quartz in the mass of the magnesite. At and near Namkul along the high road to Trichinopoly from Salem, they observed the presence of what they call "magnesian kunkar" which presumably resembles the material occurring in Mysore. Other minerals referred to by Messrs. King and Bruce Foote as occurring in the deposits of the chalk hills are chromite and talc.

These geologists held the view that the magnesites of the Salem area owed their origin to the action of hot water, steam, and carbon dioxide on the enclosing rocks. In support of this view they describe a deposit at Eashermullay, 19 miles E.S.E. of Salem bridge, where magnesite veins traverse a mass of steatite which is invaded by a basaltic intrusion. The Mysore Geological Survey adopts this view to account for the origin of the veins of compact magnesite in Mysore. Sir Thomas Holland holds much the same view. He thinks that the formation of the magnesite took place during a late phase of eruption, that it was due to the direct action of hot carbonic acid of eruptive origin on the fresh peridotite intrusion, and that serpentinization took place as an independent process subsequently to the formation of the magnesite.

In a paper on the magnesite industry of India, H. H. Dains (*Jour. Soc. Chem. Ind.* 1909) quotes the following analyses by Pattinson (No. 1) of a cargo sample of Salem magnesite; and also one by Blount (No. 2), presumably of a selected specimen:

	No. 1. Cargo sample.	No. 2. Selected specimen.
	%	%
Magnesia (MgO)	46·28	47·35
Lime (CaO)	0·78	nil
Ferric oxide (Fe_2O_3) / Alumina (Al_2O_3)	0·14	0·30
Silica (SiO_2)	1·17	0·22
Carbon dioxide (CO_2)	50·10	51·44
Combined water (H_2O)	1·30	0·27
	99·77	99·58

The mining and burning of Salem magnesite has been dealt with recently in a paper by C. H. V. Burlton (*Jour. East Indian Assoc.*, 1917). He states that the quarry faces are 40 ft. sheer, and that the proportion of the magnesite taken out in development may be about 15% of the deads, which are removed on tram lines to dumps. The magnesite is hand-dressed and stacked. The lumps of magnesite obtained by quarrying vary in size from pieces known as lump, which are double the size of a man's fist, down to pieces the size of an apple or walnut, which are known as smalls. Lump crude, to which 30% of smalls may be added, can be used for calcination in kilns. Smalls are in demand for chemical uses. The magnesite is railed to Madras, partly in crude and partly in a lightly calcined (caustic) condition. It takes 24 hours to pass the magnesite through the kilns and 2 hours through the zone of greatest heat, which is reckoned to range from 700° to 900°C., and does not exceed 1,000°C. The caustic magnesite is ground so that less than 3% remains on a 120 mesh sieve. To produce one ton of lightly calcined magnesia from 2·2 tons of crude magnesite requires from 0·2 to 0·3 ton of coal. No dead-burning has been done at Salem since the experiments which were made some years ago, and which were qualitatively but not commercially successful. In these experiments about 60 tons of magnesite was dead-burnt at a temperature of 1,700°C., but this temperature proved too high for the furnace, though it should be pointed out that in these experiments the magnesia bricks used in the furnace were merely hand-moulded.

According to Dr. W. F. Smeeth and P. Sampat Iyengar, Dept. of Mines and Geology, Mysore State, the only deposits of importance among the various occurrences known in the Mysore and Hassan districts of Mysore State are those at Dod Kanya and Dod Katur, which are situated between Mysore and Nanjangud. These are vein deposits of the normal type, in serpentine. At Dod Kanya a patch of serpentine in the Dharwar schists occupies an area about three-quarters of a mile long and a quarter of a mile wide. The serpentine is traversed by veins of magnesite which vary in thickness up to several feet. The veins tend to be either horizontal or vertical, and several of the larger masses are horizontal or but slightly inclined. It is estimated that a considerable proportion of the serpentine mass would yield about a ton of magnesite for every 10 tons of rock excavated, and that the total amount of workable magnesite would amount to several hundred thousand tons. The magnesite of Mysore is sometimes rendered impure at and near the surface by admixture with "kankar" (nodular calcium carbonate). This impurity disappears a few feet below the surface. Other impurities which require to be separated from the magnesite in mining operations are serpentine, amphibolite, and chalcedonic silica. When freed as far as possible from these impurities the magnesite is of good quality.

Australia.—Magnesite of the compact type occurs in many different parts of Australia, and at some localities there are deposits of considerable size. The more important are those of Fifield in New South Wales, Heathcote in Victoria, and Tumby Bay in South Australia, all of which have yielded supplies of magnesite in recent years. Promising deposits occur also in Queensland and in West Australia.

The magnesite occurring about 3½ miles north-west of Fifield in New South Wales shows at the surface as large rounded blocks piercing a bed of red clay, and is exposed in this manner over an area of about 100 acres. The magnesite is white and very pure. An analysis by Mingaye gave the following result: Magnesium carbonate 99·01%, lime absent, ferric oxide and alumina 0·54%, silica 0·42%. The deposit appears to be of considerable extent. According to Jaquet the cost of loading into drays at the time he wrote was 1s. to 1s. 6d. per ton. Fifield is 350 miles from Sydney, and 11 miles from the Bogan Gate—Bulbodney line. According to the New South Wales Mines Department Report for 1916, the total output of magnesite for that year was 3,761 tons, and of this total Fifield produced 3,516 tons. 200 tons were produced at Attunga and 45 tons at McIntyre.

Magnesite has been raised in small quantities in recent years at Heathcote in Victoria. The total production of the mineral in this state up to the end of 1914 was only 510 tons valued at £1,578. The Heathcote deposits yielded 189 tons valued at £3 per ton in 1915. The magnesite occurs superficially as nodules and veins near the junction of a basic serpentinous rock with granite. The veins occur in the granite as well as in the serpentinous rock. The latter is much decomposed at the surface, and it appears to be as the result of this decomposition under weathering influences that the magnesite has been formed, probably somewhat after the same style as at Fifield.

Magnesite veins in serpentine rocks are reported to occur at many localities in Queensland, but mostly in deposits of small extent. In a recent report on these occurrences, B. Dunstan states that the deposits about Marlborough and Kunwarara, between Rockhampton and St. Lawrence, are extensive. At Princhester Creek, in this district of Central Queensland, hundreds of tons of magnesite are exposed at the surface. Outcrops of magnesite are numerous at various other localities in the same district. Deposits of pure magnesite which appear to be of considerable extent occur at Mt. Pring, 12 miles from the port of Bowen. The following are analyses of some of these Queensland magnesites:

	Mt. Pring	Kunwarara (a)	Kunwarara (b)	Princhester
	%	%	%	%
Magnesia (MgO)	46·00	43·40	46·80	46·90
Lime (CaO)	1·18	0·10	Trace	1·50
Ferric oxide (Fe_2O_3) / Alumina (Al_2O_3)	Nil	1·50	0·50	0·26
Silica (SiO_2)	0·90	8·00	2·00	0·20
Carbon dioxide (CO_2)	51·72	46·70	51·30	51·30

The magnesite deposits worked near Tumby Bay in South Australia have been described recently by L. K. Ward. They are situated in the hundred of Stokes, about five miles from the town of Tumby in Eyre Peninsula. Deposits of talc occur in the same district, which is occupied by ancient metamorphic rocks. The magnesite occurs in the form of veins, which are irregularly spaced over an area of 21 by 1½ chains. The veins vary in thickness up to about 4½ ft., and a few of them appear to extend continuously for a length of 40 ft. Hematite veins run parallel to those of the magnesite, and the magnesite is in part stained superficially with iron oxide. White specimens of the weathered magnesite are scattered over the surface of the deposit, and one of the specimens was found to contain 99·38% of magnesium carbonate.

In Western Australia, magnesite has long been known to occur at Bulong, in the north-east Coolgardie goldfield, and this occurrence has been described recently by F. R. Feldtmann. Bulong is about 19½ miles east of Kalgoorlie. The rocks of the locality are described as a greenstone complex; they consist chiefly of serpentine and gabbro, with occasional masses of talcose rock. The magnesite occurs as veins in the serpentine, which is usually much decomposed in the vicinity of the veins. The veins in some places are closely crowded. The main area occupied by magnesite outcrops is over two miles in length, and the total area covered by the magnesite-bearing serpentine in this area alone is over 300 acres. Another area to the north of this occupies 80 acres, and there are others. Trial pits down to a depth of 12 ft. from the surface showed veins of magnesite up to 2 ft. thick. No estimate could be formed as to the amount of material available, but it seems clear that a large tonnage of magnesite containing over 90% of magnesium carbonate could be obtained.

Italy.—In Italy compact magnesite occurs and is or has been quarried at Castiglioncello, at Monterufoli and also on the island of Elba, all in the Firenze mining district, which includes the provinces of Pisa and Livorno. It is also mined to a small extent in the province of Turin. In Elba the magnesite is quarried in a primitive manner on the slope of Mt. Capanne in the commune of Campo, where it occurs in altered serpentine. The mineral is dug from small holes in the ground, and the holes are abandoned at a depth of a few metres. The magnesite is of the baudisserite variety; it is white, friable, rich in silica, and becomes pasty when wetted. According to analyses given by G. D'Achiardi it contains from 41 to 42% magnesia, about 44% of carbon dioxide, 1 to 3½% of lime, 8 to 9% of silica, and 3 to 4% of water. The output has been irregular. The recent production has been at the rate of 600 tons a year, and the magnesite is sold at about £1. 12s. per ton, for use in pottery manufacture.

The Castiglioncello deposits are in the commune of Rosignano Marittimo, on the hills between the Salvetti-Vada and Livorna-Vada railways, and within a mile of the latter. They consist of large veins in serpentine and occur near the contact of the latter with Eocene beds. Three veins running for a length of a kilometre are exposed, and vary in thickness from 3 to 10 metres. Large quarries were opened up in 1914-15, and kilns for calcining the magnesite have been erected recently. Local transportation to the kiln is by light railway and rope-line. The deposits are large, and, though the output during 1915 was only from 3,000 to 4,000 tons, it is estimated that a daily output of 100 tons can be maintained. The Castiglioncello magnesite is partly hard and compact, and partly friable. Its composition when dressed is approximately as follows: Magnesium carbonate 89%, calcium carbonate 5%, ferric oxide 2%, silica 3%. Magnesia bricks are made from the calcined product at Vada, by a firm which previous to the war used material imported from Greece and Austria.

The deposit at Monterufoli in the province of Pisa is a vein ranging from four to eight metres in thickness. It is found along with serpentine and occurs near the contact of this with Eocene beds, which include chalk. The magnesite is associated with quartz and chalcedony, which are removed as far as possible by hand-dressing. A sample of dressed raw magnesite gave the following analysis: Magnesium carbonate 86·02%, calcium carbonate 9·60%, iron oxide and alumina 2·63%, insoluble 1·07%. The dressed raw magnesite is carted about 2½ kilometres to the station at Monterufoli. From there it is taken by rail to Ardenza, and thence by cart to Montenero (Livorno), where it is calcined in a Dietzsch furnace.

South Africa.—We omit Mr. Crook's reference to South African magnesite, as the subject was treated in an article by Dr. P. A. Wagner quoted, in our issue of July, 1918.

Other Localities.—Of other localities where compact magnesite is known to occur in considerable quantities mention may be made of the Bridge River and Cassiar Districts of British Columbia; the island of Margarita near the northern coast of Venezuela; the island of Santa Margarita in Magdalene Bay, Lower California (Mexico), and the island of Cedros farther north; Frankenstein in Silesia; Kraubat in Austria; the Chalkidean peninsula in Macedonia; the Paphos district in Cyprus; Eski-Chehir in the province of Brusa, Asia Minor; Kraljevo and other localities in Serbia; and the area between Koumac and Voh in New Caledonia. None of these deposits has hitherto figured conspicuously in the production of magnesite, though in some cases the possibilities appear to be considerable. For some years there has been a steady but small output at Santander in Spain.

The Bridge River (British Columbia) deposits have been reported on recently by C. W. Drysdale, who describes an outcrop 52 ft. wide and 48 ft. long near the south-west end of Liza Lake. The locality is some 30 miles from the Pacific Great Eastern Railway at Bridge River Crossing on Seton Lake, but it is considered unlikely that the deposit could be profitably worked at present.

The United States imported 81 short tons of magnesite from Mexico in 1912.

The chief deposits in the island of Margarita, Venezuela, are reported to be about a mile from the port of Porlamar, and three miles from the port of Pambatar, both of which have good shipping facilities. American companies were reported to be working at these deposits in 1912, and 508 short tons were imported by the United States from Venezuela during 1915. They are reported to have been worked again during 1917, producing 10 tons per day, but shipping facilities were poor, and freight charges to New York were \$19½ per ton.

The available raw magnesite in the Eski-Chehir deposit, Asia Minor, was recently estimated at 300,000 tons, and the deposits are stated to be near the railway.

Deposits of white compact magnesite of the usual type have long been known to occur in the serpentine of Cyprus, and the magnesite is of good quality, but the deposits are reported to be of only small extent. There was an output of 15 tons from the Akamas mine in the Paphos district during 1916.

Occurrences of magnesite are stated to be abundant in the district of New Caledonia referred to above, and an analysis quoted by M. Glasser indicates that the material is of good quality, but shows 3·3% of lime. The conditions of occurrence in New Caledonia are promising, but hitherto there has been no considerable production. A trial shipment of 42 tons was reported in 1907.

(*To be continued*).

AUSTRALIAN MINING ACTIVITIES IN MALAYA AND SIAM.

In the March issue we quoted Captain F. T. Miles's historical account of the Tongkah Harbour tin-dredging enterprise, which was the beginning of the Australian participation in the mining for tin in Siam and the Malay Peninsula. This account was taken from the *Industrial Australian and Mining Standard*. In succeeding issues of that paper Captain Miles gave particulars of other Australian companies operating in these regions. The accompanying map gives the positions of the various properties. In the previous article we referred to the Tongkah Compound company as well as the Tongkah Harbour company.

The Kampong Kamunting Tin Dredging Co. was registered in August, 1913, with an office in Sydney and was the first formed in Australia for tin winning in the Malay States. The area held is 402 acres, three miles from Taiping, and it was estimated that 384 acres of this averaged 30 ft. in depth, or a total of 18,000,000 cubic yards of material. The company has two dredges, built by Chas. Ruwolt, Ltd., Richmond, Victoria. The company's operations have been successful throughout. On a capital of £140,000 it has already paid £129,500 in dividends.

Deebook Dredging, operating at Renong, West Siam, was registered in Victoria, on May 22, 1913, the registered office being at Renong Chambers, Ringwood. The area held by the company is 440 acres, of which 60 acres have been worked, so that there should be a long run before the company. The third annual report was accompanied by a plan of about 350 acres, which shows that on 20 acres 83 bores had been put down, showing an average value of 12 oz. of tin per cubic yard, and that on another block of about 85 acres 364 bores had averaged 8 oz. per cubic yard. The work of dredging was commenced on August 10, 1914, and within a day of the second anniversary of the commencement the No. 2 dredge was put to open up its own paddocks. The yearly returns since August, 1914, to May, 1915, have been as follows: To May, 1915, 209 tons; to May, 1916, 358 tons; to May, 1917, 230 tons; to May, 1918, 235 tons; June and July, 1918, 52 tons. In each case there were odd hundredweights, bringing the total for just five years to 1,085. The two dredges were built by Chas. Ruwolt Ltd. In July, 1916, No. 1 dredge capsized and sank in the paddock, and in the following November an agreement was entered into with Ronpibon Tin whereby this dredge was assigned to that company, and the Ronpibon Tin transferred about 90 acres of its property to a new company, registered as Ronpibon Extended, N.L., the subscribed capital being equally divided between the two companies.

Katoo Deebook was formed to work an area adjacent to, but south-west of, the Deebook property, which it did for a considerable time. Eventually, however, the ground was worked out for dredges, though many rich patches remained. The directors therefore decided to sell the company's dredge to the Taiping Tin Dredging Co. Operations at Katoo Deebook ceased on March 1, 1918. The directors proposed to have the remaining rich patches of ground worked by native labour and native methods on a 10% tribute.

The Bangnon Valley company's property is a continuation of that held by the Deebook and Katoo Deebook companies, lying still farther to the south-west. The company was registered in Victoria on July 2, 1914. The area held is 160 acres, of which, approximately, 62 acres have been worked. The balance of the payable ground, as proved by boring, is 23 acres, and as this is expected to be worked out by June, 1919, a new area, which has been put under offer to the directors, is now being tested by boring, the results, so far, having proved satisfactory. The dredge was built by Chas. Ruwolt Ltd.

The Trong Tin company was registered in 1914 to operate in Perak. The dredge started operations in February, 1916, and ceased in December, 1917, preparatory to transferring the company's interests to Kalumpang

The Tin Bentong company was registered in January, 1914. The property is in the state of Pahang, about 50 miles from Kuala Lumpur, and has an approximate area of 500 acres. The outbreak of the war so soon after the formation of the company resulted in a long and vexatious delay in obtaining a dredging plant, but eventually a first-class machine was obtained from the Bucyrus Co., Milwaukee. In order to expedite operations the directors purchased a steamer for its transport across the Pacific, and were fortunate enough to be able afterwards to sell the ship at a profit. The dredge is electrically driven, and was the first of its kind operating in the Malay States. It was not until May, 1918, that dredging operations were commenced; consequently only a small portion of the available 500 acres has as yet been worked.

The Larut Tin Dredging company was registered on March 4, 1914, to operate at Taiping. The approximate area is 220 acres, of which, to the end of 1917, about 20 acres had been worked in 14 months. The production of tin to that date was 569 tons, the average value of the ground treated being 1·18 lb. per cubic foot.

The Ratrut Basin Tin Dredging Co. was registered in Sydney on May 13, 1914, to operate in Siam. The outbreak of war almost immediately after the registration of the company caused the order for the dredge to be held over for a time, but eventually this was placed with Charles Ruwolt Ltd., and dredging was commenced in October, 1916. The total area held is about 395 acres, of which 258 acres have been bored and proved payable. Up to the end of May, 1918, about 30 acres had been worked, which had yielded, from 1,373,000 cubic yards, 569 tons of tin oxide, or 0·928 lb. per cubic yard. The property has proved a consistent producer.

The Austral Siamese Tin Exploration company was registered on October 25, 1915, and is, as its name indicates, an exploration and holding company, not a producer. It holds 22,680 shares in the Ronpibon Tin.

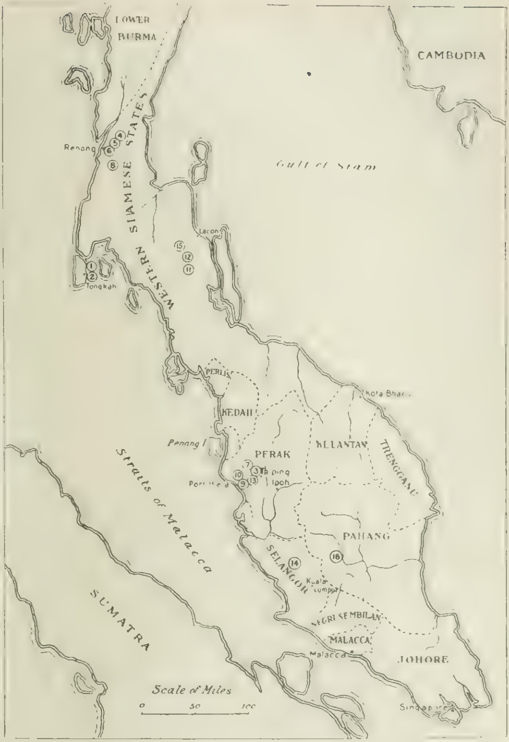
Ronpibon Tin was registered on January 17, 1916, to operate in Siam. The area held is 315 acres. The company holds a one-half interest in the Ronpibon Extended.

Ronpibon Extended was formed to carry out the terms of an agreement made between the Deebook Dredging and Ronpibon Tin, whereby the former agreed to assign their No. 1 dredge, and the latter agreed to transfer 90 acres of their land and to pay £7,000 toward the cost of transporting the dredge from Renong. The subscribed capital of £30,000 is equally divided between those two companies. The area held is 92 acres, of which about eight acres have been worked, which have yielded 204 tons, or an average of 14 oz. per cubic yard. Dredging was commenced on August 5, 1917, but, to avoid heavy expense in road making for transport, the dredge was erected at the eastern end of the property on heavy dredging ground. This having been worked out, the dredge is now on easier working ground, and satisfactory results can be anticipated.

The Asam Kumbang Tin Dredging company was registered in Sydney on January 21, 1916, to acquire the group of dredging areas held by the Austral-Malay Tin Ltd. at Taiping. The property comprises just over 500 acres, of which 490 acres has been proved payable. It is adjacent to that of Larut Tin Dredging Co. Owing to shipping and other difficulties, a supply of steel plates for the building of the dredge did not reach Melbourne until December, 1917, but the builders, Chas. Ruwolt Ltd., were able to ship it to the East before the end of September, 1918. During 1917 the company acquired an additional area of 234 acres, of which about 200 acres are considered payable. The company's property now covers upwards of 700 acres, which, it is considered, will warrant the building of a second dredge when something like normal conditions are resumed.

The Taiping Tin Dredging company was registered in the Federated Malay States on March 1, 1918, to work an area of 846 acres at Taiping, in close vicinity to the Kampong Kamunting, and Larut Tin Dredging Ltd. A share interest was given to the Katoo Deebook for its dredge on the conditions set out already. From surface indications the property is believed to be an excellent dredging proposition, and nearly 300 acres, tested by boring, gave an average value of 14 oz. per cubic yard with respect to 215 acres, the average depth of ground being 37 ft.

The Badak Mining Syndicate, operating in Kedah and registered in May, 1918, with offices at Melbourne, is for the present only a boring and prospecting enterprise, but it has to do with what appears to be a very hopeful area of 750 acres at the village of Badak, the property being about 12 miles from the new Siamese railway.



Sketch Map of Malay Peninsula and South Siam showing position of Australian-owned Tin Mines.

1 Tongkah Harbour
2 Tongkah Compound
3 Kampong Kamunting
4 Deebook
5 Katoo Deebook.
6 Bagnon Valley.
7 Trong
8 Ratrut Basin
9 Larut
10 Asam Kumbang.
11 Ronpibon.
12 Ronpibon Extended.
13 Taiping.
14 Ka[illegible]ang
15 Talerm.
16 Tin Bentong.

The Kalumpang Tin company is practically the successor of the business of the Trong Tin. The new property of the company is about 370 acres, situated about ¾ mile from Kalumpang, in the state of Selangor. The ground is made up of a low flat that runs through the entire length of the central and western sections of the land, and marks the course of the old river beds, and of slightly higher lands that occur at intervals over its whole area. The tests were confined to the richest 154 acres, on which 239 bores were put down. The central section averaged between 22.5 ft. and 22.9 ft. in depth, and showed about 19 oz. per cubic yard; the western section averaged 19.7 ft. in depth, and averaged 13.5 oz.; and the eastern section averaged 15.7 ft. in depth, giving 7.2 oz. per cubic yard. The dredge, brought from Taiping, was to be delivered under steam at the end of October, 1918.

The Talerm Tin company was registered in Melbourne on June 13, 1918, being promoted by Ronpibon Tin to acquire property in Siam. The area consists of some 200 acres, and so far 52 acres have proved 3,750,000 cubic yards of ground, averaging 2 lb. of tin oxide per cubic yard. Owing to the stony nature of the ground, however, it is proposed to work this property by means of a powerful gravel pump dredge, as the ground is unsuitable for buckets.

Kamunting Tin Dredging is a London and not an Australian company, but it is a subsidiary of the Austral-Malay Tin Ltd., which is an Australian company. The company was registered on May 2, 1913, to acquire 477 acres situated about three miles from Taiping, but the area held last year was 523 acres. The dredge commenced operations on March 22, 1915.

[There are, as our readers are aware, many English companies operating in Malaya and Siam, but the present article is not concerned with these.—Editor.]

The Mauss Concentrator.—*Engineering* for March 14 contains a description, by Edward J. Way, of the Mauss concentrator and filter. This machine, as our readers are aware, is a centrifugal separator, and has been used at the Zaaiplaats tin mine in the Transvaal for concentrating the finest slime. The article to which we refer is accompanied by illustrations. From these we gather that two or three short flat cylinders open at top and bottom are mounted with their axes vertical within a larger cylinder of the same character. The larger cylinder revolves rapidly, carrying the smaller cylinders with it, and the smaller cylinders are also revolved slowly. The pulp is fed into the smaller cylinders, where the heaviest particles build up against the outer parts of the vertical surfaces, while the water and lighter particles pass away. As the smaller cylinders revolve, the layer of concentrate comes gradually toward the centre of the big containing cylinder, and a scraper removes the concentrator, which drops into a hopper below. This machine is being applied in other ways than in tin concentration. For instance the South African Alkali Company, with works at Hamanskraal, Transvaal, uses it for extracting soda crystals from the mother liquor. It is also applicable as a continuous filter in cyaniding, and in the purification of sewage.

Electrolytic Zinc.—In *Chemical and Metallurgical Engineering* for February 15, H. E. Broughton decribes the process employed at the Ducktown copper works, Tennessee, for saving zinc. The sulphide ore at the Ducktown mines carries more zinc than copper, and the zinc is volatilized during smelting in the form of sulphide, oxide, or sulphate. This fume, in passing through the acid chambers, is converted into sulphate, and it accumulates as a sludge at the bottom of the chambers. This sludge contains also some lead sulphate produced by the corrosion of the lead lining of the chambers, and smaller amounts of ferric, copper, and cadmium sulphates. The sludge is washed so as to get the zinc sulphate into solution. This solution is very impure, and the problem was to purify it before it could be electrolysed for zinc. The author describes at some length the experiments undertaken with this object in view, and he details the method of procedure ultimately adopted in practice.

Iron Deposits in Hudson Bay.—The *Bulletin* of the Canadian Mining Institute for February contains a brief paper by E. S. Moore describing the iron-ore deposits on the Belcher Islands in Hudson Bay. Mr. Moore wrote a longer paper on the same subject in the *Journal of Geology* last year. Briefly the result of Mr. Moore's examination was that the deposits are too lean and silicious to be of any commercial importance. The islands are in the south-east part of the bay, about 70 miles from the mouth of the Great Whale river. They consist of a series of comparatively low ridges, 70 miles long and up to 5 miles wide, and have many deep narrow bays. They are formed of ancient folded sediments, lava flows, and intrusive sheets, with back-bones of igneous rocks. Their exact geological age is not certain, various geologists placing them from early Pre-Cambrian to Cambrian. There are no trees, only mosses in the way of vegetation. The sea is ice-locked in winter. Thus the islands would not offer much attraction to labour. The hematite deposits are undoubtedly vast, but there are so many massive beds of jasper and the ore is so much interspersed with jasper that they could not be profitably worked. The main reason for the publication of Mr. Moore's paper was to disabuse engineers of the idea that the deposits were valuable, an idea often promulgated in certain directions.

Volatilization of Gold.—At the March meeting of the Institution of Mining and Metallurgy, Sir Thomas Kirke Rose, chemist to the Royal Mint, read a paper detailing experiments relating to losses of gold during melting. He had found that the losses at the Mint were 0·014% of the gold treated, averaging in the aggregate £9,700 yearly. In the experiments he heated molten gold by a reverberatory flame. He found that the metals accompanying gold, particularly silver and copper, as in standard gold, will take up oxygen, and will afterwards effervesce in a reducing atmosphere until the oxygen has been removed. Similarly hydrogen, and in a less degree carbon monoxide, is occluded by such alloys, and the metal then effervesces in an oxidizing atmosphere. During this effervescence, showers of globules are thrown up, and the smaller ones, especially those less than 0·001 millimetres in diameter, are carried away by the draught. These travel far along the flue and up the chimney. The action is not true volatilization.

Lightning River.—The *Canadian Mining Journal* for February 12 contains an article by A. G. Burrows and C. W. Knight describing the Lightning River gold area, which lies to the south of Upper Abitibi Lake, Ontario, near the Quebec boundary. The authors made an examination for the Geological Survey last summer. Gold was first discovered in August, 1917, by Howey, Cochenour, and Willans. Their claim is in Holloway township and is reached by road from Matheson on the Temiskaming & Northern Ontario Railway, a distance of 40 miles. This road passes the Crœsus, a notably rich mine. Work on the claim has been largely confined to an examination of the vein in which the original discovery of gold was made in August, 1917. This vein has been traced by means of pits and trenches a distance of 175 ft. At the westerly exposure it is in the basalt, and at the easterly exposure in the rhyolite. At the west outcrop in the basalt an inclined shaft has been sunk on the vein where the dip is 23° south. When the property was last visited by the authors the shaft had reached a depth of 35 ft. and the vein was still in the basalt, which rock lies to the north of the rhyolite, the strike of the contact of the two rocks being to the south of west and the dip being about 80°S. When the shaft penetrated the contact of the basalt and rhyolite the low dip of the vein was maintained, and the contact between the rocks has been displaced a distance of 4 ft. on the plane of the vein. This evidence points to the formation of the vein along an inclined fault that intersected the rock formations. The vein structure, as revealed in the shaft to a depth of 35 ft., shows a main persistent quartz vein, varying in width from 1 in. to 10 or 12 in., with an average width of about 4 in. Roughly paralleling this main vein there are a number of narrow quartz veinlets usually less than an inch in width and more or less discontinuous, the whole partaking of the character of a sheeted zone produced by shearing that accompanied the formation of the fault. This zone varies in width from about 2 to 3 ft. The quartz veins carry considerable calcite often of a pink colour, and also pyrite, chalcopyrite, and zinc blende. In the main vein the pyrite, which is the most abundant sulphide, frequently occurs in a roughly banded arrangement, parallel to the walls, and is also concentrated between the quartz and the wall-rock. Fragments of country rock occur in the vein and are said to be more numerous as the contact between the basalt and rhyolite is approached. The gold usually occurs in a fine condition with the pyrite, but samples from the main vein often show gold in the quartz visible to the eye. The rock adjacent to the veins has been mostly replaced by silica and carbonate solutions, accompanied by pyrite. Samples of the replaced rock effervesce strongly with acid. Away from the veins the original lath-like structure of the plagioclase felspars is well preserved. The shaft is reported continuing to a depth of about 70 ft., and work was stopped after the rhyolite had been penetrated for 20 ft. The rhyolite contains scattered crystals of pyrite, and on the surface to the south of the shaft there are numerous loose fragments of the rock. Native gold has been observed in some of the fragments. From a number of assays of the surface rhyolite an average assay-value of about $1·50 in gold per ton was obtained. Similar low values have been reported in this rock from a number of places along the band of rhyolite for 5 miles. Some work has been done on quartz veins that carry pyrite occurring in this or a parallel band of rhyolite. Other claims worked are the Taylor-Horne, the Cochenour, and the McDonald.

SHORT NOTICES.

Shaft Timbering.—In the *Engineering and Mining Journal* for February 22, A. Neustaedter discusses the timbering of inclined shafts and describes a method of alignment.

Diamond-Drilling.—At a meeting of the North Wales branch of the National Association of Colliery Managers held on February 20, J. Walker Steele recounted his experiences with diamond-drilling for a coal seam in much disturbed and faulted ground. This paper is printed in the *Iron & Coal Trades Review* for March 7.

Explosives. — In the *Mining and Scientific Press* for February 22, R. S. Lewis gives a general outline of explosives at present used in blasting.

Stope-Measuring at Great Cobar.—At the March meeting of the Institution of Mining and Metallurgy, a paper by W. S. Curteis was presented describing methods of measuring broken rock in the stope, devised by the author at Great Cobar.

Grinding Mill.—The *Industrial Australian and Mining Standard* for January 2 describes the Park roller mill for grinding ores, made in Melbourne.

Ore Reserves.— The *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa for January contains a paper by G. A. Watermayer on the application of the theory of probability to the determination of ore reserves.

Oil-Well Drilling.—At the meeting of the Institution of Petroleum Technologists, held on March 18, M. A. Ockenden and Ashley Carter read a paper on the plant used in the percussion system of drilling oil-wells. The paper traces the development of the cable system, and gives details of the modern plant; an appendix contains specifications of standard American rigs

Flotation.—In *Chemical and Metallurgical Engineering* for February 15, Glenn L. Allen describes the method and plant employed at the Shattuck-Arizona mine for floating lead-carbonate ore, giving the ore a sulphide coating by the action of a solution of sodium sulphide. We gave an outline of the author's investigations in the issue of September, 1916

Concentration Calculations. — At the February meeting of the Institution of Mining and Metallurgy, E. Edser presented a paper describing methods of calculating the efficiency of concentration.

Milling and Metallurgical Formulae.—In *Chemical and Metallurgical Engineering* for March 1, R. S. Lewis gives a collection of a great many formulæ relating to sampling, concentration, specific gravity of pulp, efficiency of cyanide extraction, etc. An appendix contains a bibliography of recent articles.

Zinc Metallurgy.—In *Chemical and Metallurgical Engineering* for March 1, Parker C. Choate prophesies a difficult time for zinc smelters owing partly to the competition of electrolytic zinc and partly to the increased costs of labour, clay, and fuel at the smelters. He suggests that the zinc firms should combine to evolve a continuous process using vertical retorts, and employing the lime reaction with the raw ore intead of roasting and reducing the oxide. The smelting should be done at lignite deposits where gas could be obtained at low cost owing to the by-products paying for mining and gasifying.

Nickel Refining.—In the *Engineering and Mining Journal* for March 8, W. L. Wotherspoon describes the new refining works of the International Nickel Co. at Port Colborne, Ontario, where matte produced at Sudbury, Ontario, is treated for the separation of nickel and copper.

Copper Alloys.—At the March meeting of the Institute of Metals, Dr. W. Rosenhain and D. Hanson read a paper on copper alloys of high tensile strength and great ductility. Some of these alloys contained aluminium, manganese, or both, while others contained manganese and zinc, or nickel and zinc.

Corrosion.—At the March meeting of the Institute of Metals, Drs. G. D. Bengough and O. F. Hudson presented their fourth report on corrosion of copper, brass, and alloys, especially as regards the internal corrosion of tubes.

Australian Exploration.—The *Geographical Journal* for March contains a paper by Dr. Griffith Taylor on the physiographic control of Australian exploration. It contains much interesting information relating to rainfall, drainage, vegetation, contours, and population.

Tin in Tasmania.—At the February meeting of the Institution of Mining and Metallurgy, C. W. Gudgeon presented a paper describing the Giblin tin lode, in Tasmania.

Barite Deposits.—In *Economic Geology* for February, W. A. Tarr describes the barite deposits of Missouri.

Sulphur in the Southern States.—*Chemical and Metallurgical Engineering* for February 15 prints an article describing the sulphur-bearing saline domes on the coast of the gulf of Mexico, and the progress of the American sulphur industry.

Manganese in Cuba.—A paper on the manganese ore deposits in Cuba has been presented by E. F. Burchard to the American Institute of Mining Engineers. It is not printed in the *Bulletin*, but copies will be sent to those who ask for it.

Geology of Hayti.—The *Journal of Geology* for December contains an article by W. F. Jones giving the results of a geological reconnaissance of Hayti, West Indies.

Wolfram in Bolivia.—At the February meeting of the Institution of Mining and Metallurgy, G. F. J. Preumont presented a paper on wolfram mining in Bolivia.

Chanarcillo, Chile. — In *Economic Geology* for February, W. L. Whitehead gives a long geological and petrological description of the veins of Chanarcillo, 30 miles south of Copiapo. These veins have been celebrated producers of complex ores high in silver, with less important amounts of copper.

Venezuelan Minerals.—In the *Engineering and Mining Journal* for March 8, C. F. Z. Caracristi gives an outline of the mineral industry of Venezuela, including gold, copper, petroleum, asphalt, magnesite, and coal.

Coal-Dust as Fuel.—The *Mining and Scientific Press* for February 15 describes and illustrates the Buell-Santmyer system of using pulverized lignite for steam-raising purposes.

Peat as Fuel.—In the *Engineer* for March 14, J. B. C. Kershaw commences a series of articles on the utilization of peat for power purposes.

Water Power in Sweden.—*Engineering* for March 7 gives an account of recent projects in connection with hydro-electric generation of power in Sweden.

Canadian Industries.—At a meeting of the Royal Society of Arts held on March 4, Professor J. C. McLennan delivered a lecture on science and industry in Canada. Among other things he reviewed the mineral resources and gave details of the possibilities in connection with hydro-electric power.

Horace V. Winchell.—In the *Mining and Scientific Press* for February 15, T. A. Rickard gives the report of an interview with Horace V. Winchell, the newly elected president of the American Institute of Mining Engineers. Mr. Winchell's father and uncle were professors of geology and state geologists in Minnesota and Michigan respectively, and his brother holds a similar position in Wisconsin. His first work was in connection with the iron deposits in the North-West. Later, he established the geological department at Anaconda, and developed coal deposits in Alaska, and he has paid professional visits to the Argentine and Siberia.

Quin's Metals Handbook. By L. H. Quin. Pocket size, cloth. 250 pages. Price 3s. 6d. net. London: The Metal Information Bureau, Ltd., 7, East India Avenue.

Mr. Quin's records of the metal markets are well known. His *Metal Bulletin* published twice a week keeps readers well posted in market movements, and his yearly handbook contains a valuable summary. It is not easy being a statistician nowadays, for war conditions have greatly interfered with the publication of details. We need not now describe the scope and contents of the handbook; it is too well known.

RECENT PATENTS PUBLISHED.

369 of 1918 (122,870). F. R. RAND and CLAUDE VAUTIN, London. An alloy of aluminium containing 85 to 97½% aluminium, and the remainder added as a cupro-nickel alloy consisting of 20 to 25% nickel and 75 to 80% copper.

2,130 of 1918 (122,897). E. A. GAILLARD, Paris. A process for concentrating low-grade phosphates.

2,252 and 2,253 of 1918 (113,957 and 113,958). L. E. SAUNDERS and R. H. WHITE, Niagara Falls, N.Y. An abrasive made of crystalline alumina with 4% or so of zirconia.

3,505 of 1918 (123,587). V. G. YOURIEFF, London. Method of producing spongy lead suitable for accumulator plates.

3,591 of 1918 (123,418). C. C. CITO, Brussels Recovering copper from low-grade sweepings by giving the latter a chloridizing roast.

4,538 of 1918 (123,201). W. ROSS, Montreal. In grizzlies where the bars are on an endless chain passing round sprocket wheels, forming the bars in pairs in such a way that the openings between are greater while on the return journey underneath, so as to prevent them being clogged with material.

6,111 of 1918 (116,266). TITAN CO., Christiania. Method of refining crude titanium hydrate for the production of compounds suitable for use as pigments.

7,841 of 1918 (123,243). E. E. & P. C. DUTT, Jubbulpore, India. Method of producing aluminium chloride and aluminium sodium chloride from common salt and clay.

11,020 of 1918 (118,094). E. C. BRACQ, Paris. In vertical roasting furnaces with series of hearths, an improved method of mounting the arms and of withdrawing the central shaft for repairs and replacements of the arms.

12,001 of 1918 (120,035). NORSK HYDROELEKTRISK KVAELSTOFAKTIESELSKAB, Christiania. Making nitrate of alumina from kaolin by the action of nitric acid under pressure in an autoclave.

12,781 of 1918 (123,272). G. P. HULST, Hammond, Indiana. Improved method of removing copper, antimony, and other impurities from silver-lead bullion.

21,553 of 1918 (123,705). H. W. HARDINGE, New York. In conical grinding mills, providing means for preventing the discharge of coarse particles and returning them to the inlet end by means of pipes arranged externally and revolving with the mill.

COMPANY REPORTS

Dolcoath.—The report of this company, operating at Camborne, Cornwall, for the half-year ended December 31, shows that 28,716 tons of ore was raised, from which 403 tons of tin concentrate was obtained. The amount of ore compared with 32,783 tons during the previous half-year, and with the maximum, 60,631 tons, mined during the second half of 1912. The yield of concentrate per ton of ore was 31·45 lb., as compared with 28·97 lb. during the previous half-year. The revenue from the sale of concentrate was £76,103, and from arsenic £4,494. Other revenue brought the total to £83,037. The working cost was £68,591, being 47s. 9d. per ton. The advance in the cost of mining is well reflected by the fact that during the second half of 1912 the figure was 21s. 1d. per ton. The royalties have now disappeared, and the interest on debentures was £3,173, as against £4,630 paid as royalties during the second half of 1917. The net profit was £11,916, which was carried forward. As regards output, development, and prospects, we quote in full the report of the managing director, R. Arthur Thomas

"The Williams shaft has contributed 44% of the total tinstuff drawn and 40·6% of the black tin sold, being an increase on the former of 2·9% and a decrease on the latter of 7·6%. The 375 fm. level is being driven east of the New East shaft in the foot-wall granite; cross-cuts are put in at approximate intervals of 10 fm. to obtain run stuff from the old workings, which though not rich leave a margin of profit, having regard to the fact that the ore can be cheaply worked. New Sump section of the mine has contributed 4% of the total tinstuff drawn and 4·8% of the total black tin sold, being a decrease in each instance of 6·6% and 2·2% respectively. The gradual falling off in the production from this shaft is due to the fact that the tinstuff mined from this district is now transferred to the Williams shaft, but when more miners are available it is hoped the production will be considerably increased. The 338 fm. level is driven 30 fm. east of New East shaft on a north branch of the main lode, the last 20 fm. averaging 45 lb. of black tin per ton over 6 ft., the width of the drive. It is intended shortly to cross-cut south to the old workings, from which it is anticipated considerable quantities of moderately productive tin ground will be available for working. The 400 fm. level has been driven 14½ fm. west of No. 4 winze west of Eastern shaft, and has produced on an average 20 lb. of black tin per ton; an extension of this level will render available for working some known tin ground further in advance. The drivage of the 190 fm. level east of New Sump shaft has just been commenced, with every prospect of opening up considerable quantities of tin ground of about the present average of the mine. Old Sump section of the mine has contributed 8·8% of the total tinstuff drawn and 3·1% of the total black tin sold, being an increase of 2·3% and 1·4% respectively as compared with the preceding six months. The eastern section of the mine has contributed 35·3% of the total tinstuff drawn and 37·4% of the total output of black tin from the mine, being the same for tinstuff and an increase of 3·3% for the black tin, as compared with the previous six months. Wheal Harriett section has contributed 6·3% of the total tinstuff drawn and 13% of the total black tin sold, being an increase of 0·1% and 5·6% respectively as compared with the previous six months.

"It will be observed that a sum of £4,494. 8s. 5d. has been secured for crude arsenic for the current six months, there having been sold 65 tons 2 cwt. as compared with 42 tons for the previous six months. The production of arsenic will be increased as soon as men are demobilized and return to work in the mine.

"The general shortage of miners has continued during the last six months, and in consequence thereof practically no development work has been done. The following comparative development figures show the extent to which this work has been curtailed during the period of the war, due to such large numbers of our miners having joined the Forces: 1914, 723 fm.; 1915, 301 fm.; 1916, 263 fm.; 1917, 195 fm.; 1918, 67 fm.

"As previously advised, the scheme of diamond-drilling has been completed, with the exception of boring below the bottom workings of the mine, which has not yet been possible, but this should be undertaken during the next few months."

Rio Tinto.—The report for 1918 of this company, which operates big copper-sulphur mines in the south of Spain, following the practice initiated on the outbreak of war, does not contain any record of output. The net profit was £1,561,194, out of which £81,250 was paid as preference dividend, and £937,500 as ordinary dividend, being at the rate of 50% for the year. Last summer, the company, at the request of the British Government, created peseta mortgage bonds in Spain for fifty million pesetas. These were sold on the Spanish market, and the proceeds were placed at the disposal of the British Government. The company's exchange operations have benefited by this transaction, and the liability toward the Spanish bondholders is kept fully secured by a Treasury guarantee together with the deposit at the company's bankers of sufficient British Government securities. During the year 1918, great difficulty was experienced in connection with all branches of the company's undertakings. These difficulties arose chiefly from lack of freight and materials, which necessitated reduction in the working and output of several departments. For want of fuel, all the steam shovels and many of the locomotives were unable to work, and the mining and other operations necessary for producing and shipping the pyrites needed by the British and other explosives factories were largely carried on by hand labour. Smelting operations were also affected, and could only be carried out on a reduced scale. Not only was the supply of fuel reduced far below necessities, but what little was obtained often cost ten times the pre-war rates. Iron used in the precipitation of copper was so high in price that the cost of copper produced by the wet process was double that of normal times. The price received for copper during the year compensated only to a limited extent for the great increase of costs. Since the Armistice, the purchasing of copper has fallen off to a very large extent. The demand for pyrites for sulphur content for industrial purposes has not yet revived, but, when world conditions again become more normal, the directors believe there is nothing in the company's affairs that should prevent a return of its former prosperity.

Jibutil (Anantapur) Gold Mines.—This company was formed in 1911 by John Taylor & Sons to work a gold mine in Anantapur district, Madras Presidency, that had been developed by the Nundydroog company. Additional capital was raised in 1912 and 1913. Recently it was announced that the developments do not warrant a continuation of operations, at least under present conditions. The report for the year ended September 30 last shows that 18,200 tons of ore was milled, yielding 5,722 oz. of fine gold, which realized £24,266. The loss for the year was £8,054. The plant and stores are being sold, and if sufficient funds are obtained thereby, the directors intend to continue exploration at the most promising point, the 500 ft. level north at No. 1 Prospect shaft.

Mysore.—This company was formed in 1880 by John Taylor & Sons to acquire old gold workings in the Kolar district, Mysore State, South India. Dividends have been paid continuously since 1886, but since 1915 the developments have been discouraging. The report for 1918 shows a considerable fall in the output, and the decrease, which started three years ago, has become more pronounced. The ore milled amounted to 293,186 tons, from which 127,536 oz. of gold bullion was extracted, and 568,635 tons of current and old tailings yielded 66,127 oz. of gold bullion. The total gold was equivalent to 174,300 oz. fine, and realized £739,192 In 1917, the figures were 307,126 tons and £842,056. The working cost was £443,845, royalties £39,828, income tax £77,630, and expenditure on capital account £51,576. The shareholders received £137,250, at the rate of 45%, as compared with £259,250 and 85% the year before. The fall in output was chiefly due to the lower grade of the ore treated, but rock-bursts and winding accidents also contributed. The ore reserves have been fairly well maintained, the figure now being 910,000 tons, as compared with 939,000 tons at the end of 1917. The average assay-value is not given in either case, but a further reduction in the yield per ton milled is foreshadowed. The maintenance of the reserve was effected chiefly by important discoveries made during stoping in McTaggart's section, and no considerable amounts of ore were disclosed during development in either McTaggart's or Ribblesdale's sections.

Ooregum.—This company belongs to the John Taylor & Sons group operating gold mines in the Kolar district, Mysore State, South India. Mining commenced in 1888, and dividends have been paid continuously since 1891. The report for 1918 shows that 152,780 tons of ore was milled, yielding 77,185 fine oz. by amalgamation, while 205,488 tons of current and accumulated tailing yielded 12,446 oz. by cyaniding. The total yield was 89,631 oz., realizing £380,222. The working cost was £222,224, the royalties £21,382, expenditure on new circular shaft £9,471; depreciation of buildings and plant £15,000; and placed to reserve £5,000. The dividends totalled £102,193, being at the rate of 35% on the preference shares and 25% on the ordinary shares. The developments at depth in Bullen's section show poor results, but in Oakley's section the results are more hopeful. The reserve is estimated at 392,690 tons, a fall of 22,093 tons during the year. A decrease in the yield per ton is foreshadowed.

Nundydroog.—This company belongs to the John Taylor & Sons group operating gold mines in the Kolar district, Mysore State, South India. Milling started in 1882 and dividends have been distributed regularly since 1888. The report for 1918 shows that 102,731 tons of ore was raised, yielding 80,002 oz. of gold bullion by amalgamation; 73,731 tons of current sandy tailing and 80,241 tons of current and old slime tailing was cyanided for a return of 7,953 oz. of gold bullion. The total yield was 78,757 oz. fine, realizing £333,759. The percentage of recovery was 98·3. The working cost was £191,389, royalties £21,175, outlay on plant and buildings £13,814, and expenditure on shaft-sinking £15,639. The shareholders received £63,675, the dividend being at the rate of 22½%. This distribution is the smallest on record. The fall is accounted for by increased costs, the lower assay-value of the ore raised, labour scarcity, and influenza. As regards ore reserves, these are calculated at 202,300 tons, about the same as a year ago. This figure would not have been maintained but for the fact that stoping operations yielded more ore than was provided for in the estimates. The new circular shaft has been sunk to a depth of 1,744 ft.

Sudan Gold Field.—This company was formed in 1904 by John Taylor & Sons to prospect in the Sudan between the 20th and 22nd parallels of latitude. Eventually operations were centred on the Om Nabardi property. Additional capital was raised in 1908, and dividends were paid for the years 1914, 1915, and 1916. The report for 1918 shows that 20,880 tons of ore was raised, which yielded 11,248 oz. of gold bullion by amalgamation. In addition 15,025 of sandy tailing yielded 1,021 oz. of bullion, and 1,535 tons of slime yielded 150 oz. The total gold realized £43,944, while the working cost was £45,410. The company recovered £12,047 paid as Excess Profits Tax, after the raising of the statutory percentage of profit. This is the first year of regular work that has shown a loss, and the causes are about equally divided between higher costs and lower yield per ton. Owing to shortage of labour, development has been greatly restricted, and the reserves have been consequently depleted. Moreover it has been necessary to eliminate from the estimate some ore that will not meet the present costs. The policy at present is to do as much development as the surplus revenue will permit.

Tongkah Harbour Tin Dredging.—This company was formed in Tasmania in 1906 to dredge for tin on the shore at Puket, Tongkah Island, off the west coast of Siam. The moving spirit of the enterprise was Captain E. T. Miles. The report for the year ended September 30 last shows that all five dredges were at work, treating altogether 3,383,250 cubic yards for a yield of 1,314 tons of tin concentrate. The yield per yard was 0·87 lb., as compared with 0·723 lb. the year before; but on the other hand the amount treated was less, comparing with 3,682,550 yards. Repairs have been frequently necessary, and owing to the absence of material, some of the dredges are not in good condition. The dredge working in deep water has proved the ground to be richer than the bore-holes indicated, and the directors are encouraged to construct new dredges to work the ground when opportunity presents. Owing to the outer harbour being exposed to periodical storms, dredges with much stronger hulls than usual will be required. The accounts show an income of £221,561 after payment of royalty, and a net profit of £118,920. The dividends absorbed £90,000.

Champion (Nigeria) Tin Fields.—This company was formed in 1909 as the Champion Gold Reefs of West Africa. The gold properties not proving of importance, the name was changed in 1911, and attention was directed to tin. The company floated the Naraguta (Nigeria) Tin Mines, the Lucky Chance Mines, and the Tin Fields of Northern Nigeria, and has large interests in the Berrida and Naraguta Extended companies. S. R. Bastard is chairman and C. G. Lush is consulting engineer. The report for the year ended June 30 last shows an income of £29,281 derived from profits on the sale of shares, receipts of £1,965 from dividends and interest, and a revenue of £3,729 from the sale of gold. After allowing for expenses and depreciation, the net profit was £22,970. Dividends absorbing £10,000 have been paid. Prospecting for tin was recommenced at the beginning of 1919. The gold industry continues to be barely payable, but new ground is being acquired. As regards the Berrida and Lucky Chance companies, these are interested in the Poldice and West Poldice tin-wolfram mines in Cornwall. Operations at these properties have been delayed, but it is hoped that the Martin glass concentration tables will be working shortly.

Knight Central.—This company was formed in 1895 to work property in the east Rand, to the south of Knights Deep. Milling started in 1903, but little profit has ever been made. The control recently passed from Neumann's to the Central Mining group. A year ago the results of development were so poor, especially below the dyke, that a sale or alternatively a closure was contemplated. No sale could be effected, however, and in the meantime a discovery of ore induced the directors to continue operations. During the past year the results have been comparatively satisfactory. The report for 1918 shows that 282,250 tons averaging 6·26 dwt. per ton was raised and sent to the mill without sorting. The yield of gold by amalgamation was 52,119 oz., and by cyaniding 31,577 oz., making a total of 83,696 oz., worth £347,927, or 24s. 8d. per ton. The working cost was £332,287, or 23s. 7d. per ton, leaving a working profit of £15,649, or 1s. 1d. per ton. A year ago the yield and cost per ton were 20s. 9d. and 20s. 6d. respectively. The ore reserve at December 31 was estimated at 275,000 tons averaging 6·9 dwt., as compared with 280,800 tons averaging 5·9 dwt. the year before.

Tweefontein Colliery.—This company was formed in 1907 by Henderson's Transvaal Estates to work the colliery on Tweefontein farm in the Middelburg district of the Transvaal. In May, 1917, an amalgamation was effected with Tweefontein United Collieries. The report for 1918 shows that the sales of coal up to July 1 amounted to 218,664 tons, and that the output from the combined collieries during the second half of the year was 517,967 tons. The profit was £22,446, out of which £4,250 was paid as excess profits tax for 1917. The balance brought forward from the previous year was £22,120. The dividends paid and declared for the year totalled £19,500, of which £7,500 went to the preference shares, being 10%, and £12,000 to the ordinary shares, being at the rate of 20%.

Le Roi No. 2.—This company was formed in 1900 by the late Whitaker Wright to acquire the Josie, Annie, Poorman, and other gold-copper mines at Rossland, British Columbia. Since 1901 the control has been with Lord Ernest Hamilton, and the management in the hands of Alexander Hill & Stewart. The report for the year ended September 30 last shows that 19,642 tons of ore was raised and sent to the Trail and Granby smelters. This ore averaged 8·6 dwt. gold per ton, 1 oz. silver, and 1·7% copper. No concentrating ore was mined. The gross value of the ore shipped was $351,736, and the net amount realized was $203,060. The profit for the year was £4,918, which was carried forward. The mines contain many complicated veins difficult to develop and follow. Plans are now being prepared for sinking below the 1,850 ft. [illegible] der to explore the South Rodney ore-body in depth.

MYSORE GOLD MINING CO., LTD.

Directors : Captain W. B. McTaggart (*Chairman*), Lord Ribblesdale (*Vice-Chairman*), Lord Glenconner, Hon Mark F Napier, Sir J. D. Rees, John Taylor, Robert Taylor *Managers :* John Taylor & Sons. *Secretary :* W. F. Garland. *Office :* 6, Queen Street Place, London, E.C.4. *Formed* 1880. *Capital :* £305,000 in shares of 10s. each.

Business : Operates a gold mine in Kolar district, Mysore State, South India

The thirty-ninth ordinary general meeting of the Mysore Gold Mining Company, Ltd., was held on April 10 at Cannon Street Hotel, London, E.C., the Right Hon. Lord Ribblesdale (Vice-Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for 1918, said he wished they had a statement of affairs to consider more like the old piping days which for very many years they had been used to. However, as practical men or philosophers, or even as mining shareholders, most shareholders must have been accustomed to the ups and downs of mining enterprises, and must have known quite well that reduced profits must meant reduced dividends. The reduced profits were almost inevitable, having regard to the very great difficulty under which mining operations had been carried on during the war, and also owing to the tremendous cost of all mining materials and of every supply required out there, which must materially add to working expenses. These adverse factors would have alone been sufficient themselves to account for the reduction in the profit, but, as shareholders also knew, that the lower parts of the mines had not developed so richly as they would have liked. This diminished output and the heavily increased cost they were, of course, prepared for; but they had also been exposed this year to what Captain Bullen in his report spoke of as "a perfect series of calamities" This series of calamities had tended to considerable disorganization both underground and at the surface, and they were quite outside their control. They had also tended to reduce the output and to increase the working costs. In August last, and again in October, the field was visited by an epidemic of influenza in a very severe form. They had 13,600 cases and 960 deaths. That was on the Kolar field, not on the Mysore mine alone. Then, again, the Mysore mine, which had hitherto not experienced these disturbances, was visited by two serious rock-bursts, which, in addition to the repairing and reconstruction necessitated, interfered with very important stoping areas. Another contributory cause of misfortune was the over-winding of the engines at Edgar's shaft. That caused material damage to the shaft equipment and great delay in the hoisting operations through this, which happened to be the main hauling-way of the mine.

During the year they crushed 293,186 tons of ore, and treated by cyanidation 568,635 tons of tailing and slime, for a total production of 193,663 ounces of bar gold, which realized £739,192. Deducting the royalty payable to the Mysore Government, and adding interest on deposit account and investments, etc., they had a total to the credit of revenue account of £708,366. The revenue expenditure was £443,845, and the resultant profit £264,521. On October 12 last an interim dividend of 2s. 6d. per share was paid, amounting to £76,250, and other deductions, including income tax, £77,630, and an amount written off expenditure on capital account, £51,576, left an available sum for the final dividend for the year of £63,910. This admitted of a payment of 2s. per share, less income tax, and such dividend was paid on April 2. The total distribution for the year was thus 4s. 6d. per share, or 45% upon the capital of the company. The gold extraction was less by 23,654 ounces and £102,863 in value, and the profit was less by £139,775 as compared with 1917. The reserves stood at the high figure of 910,000 tons, and with all the difficulties during the year and the disappointment in developments, they had only been depleted by 29,000 tons from what they stood at on December 31, 1917.

For a great many years Mysore was a high-grade mine, that is to say, they had very large reserves of rich ore. For some three years past they had not made any very great discoveries, and the lower sections of the mine had not been as productive as they could wish to see. The position was that at present they were dealing with a lower-grade proposition than formerly, and until they made further discoveries of rich ore the present output of gold could not improve. They hoped it would, but he did not want to raise hopes or to say things which might not be justified. Mr. Bullen stated that at Ribblesdale's section, which was the deepest part of the mine, he had considerable hope that they were entering another ore-shoot, and the development there would no doubt be watched with great interest. Owing to the partial failure of the monsoons, which they depended upon a good deal, because they very much affected the food supply of the Kolar field, and food supply naturally affected labour, they were rather nervous about that matter, but that had more or less passed off. The were now rather anxious about the water available in the Betamangalam tank, by which the mines of the Kolar field were supplied. The tank was low just now, and although such measures as it might be practicable to adopt had been taken with a view to obviating inconvenience, pending the advent of the next rainy season, there was some little anxiety about that. However, these matters were receiving the consideration of the Mysore Government and of the companies concerned.

Mr. John Taylor seconded the motion, and after Mr. Edgar Taylor has given details of the work at the mine, the motion was carried unanimously.

NUNDYDROOG COMPANY, LIMITED.

Directors: Captain W B McTaggart (*Chairman*), P. C. C. Francis, Vere H. Smith, John Taylor, Robert Taylor. *Managers:* John Taylor & Sons. *Secretary:* W. L. Bayley. *Office:* 6, Queen Street Place, London, E.C.4. *Formed* 1880, reconstructed 1893. *Capital:* £283,000 in shares of 10s each.

Business: Operates a gold mine in Kolar district, Mysore State, South India.

The twenty-sixth ordinary general meeting of the Nundydroog Company, Ltd., was held on April 9 at the Cannon Street Hotel, London, E.C., Mr. J. Taylor presiding.

The Chairman, in moving the adoption of the report and accounts for 1918, said that 102,731 tons of ore was treated and 73,731 tons of tailing and 80,241 tons of slime were also dealt with, the total production from these sources being 78,757 oz. of fine gold, worth £333,759. At their last annual meeting the Chairman was able to report that the extraction of the gold from the ore had improved from 93·35% in 1916 to 96·1% in 1917. During 1918 a further improvement had taken place, 98·3% having been won. The average value of the final residues was only 6·2 grains of gold per ton. The receipts for the year, after allowing for royalties, amounted to £314,813, and the expenditure to £191,189, leaving a profit of £123,424, as against £141,558 in the previous year. The profit and loss account was credited with £127,077, and debited with £84,513, and there thus remained a balance to the credit of £42,564. The amount on the debit side included £13,814, the outlay on new buildings, machinery, and plant; £16,639, the further cost incurred in connection with the sinking of the new circular shaft; and £5,000 written off the value of the bonds held in the Indian and General Mining Trust in view of the depreciation in the value of the shares held by the trust in companies situate on the Anantapur Goldfield. Out of the credit balance they had paid the balance dividend of 1s. 3d. per share, which amounted to £35,375, and allowed of £7,189 being carried forward to the present year's account. The dividends for the year under review amounted to 2s. 3d. per 10s. share, less income tax. The falling off in the amount of dividend paid was to be regretted, but was inevitable in view of the increased costs and the unfortunate rise in the rate of exchange. A favourable feature was the small reduction of only 500 tons in the estimated reserves of ore.

Mr. P. C. C. Francis seconded the resolution.

Mr. Edgar Taylor then gave particulars of work at the mine. Level driving and cross-cutting during the past year amounted to 6,333 ft., showing the considerable increase of 1,286 ft., though the total footage of development work was only 278 ft. more than in the previous year, due to there having been considerably less progress in shaft-sinking, winzes, and rises. This came about partly because Kennedy's shaft had been suspended at the 4,000 ft. level, as the development of this section of the mine below that level would be carried on from the new subsidiary vertical shaft. This latter would eventually link up the new circular shaft that was being sunk from surface, and had already attained a depth of 1,744 ft. vertical, equivalent to the 2,150 ft. level. Another subsidiary shaft was to be sunk below the 3,800 ft. level in Taylor's section of the mine further south. With regard to the new circular shaft, two heavy rock-bursts occurred near the bottom of the shaft, which considerably delayed sinking. The permanent direct-acting winding engine was now installed here and should facilitate further work. Development results throughout the mine had, on the whole, been below expectation. This was more especially the case north of Oriental shaft at the 3,800, 3,650, and 3,500 ft. levels. In the neighbouring Balaghat mine to the north the levels which correspond to the 3,800 and 3,650 were in good ore when suspended within a few feet of the southern Balaghat and northern Nundydroog boundary. It was therefore probable that an improvement would presently be met with in the value of the lode in these ends as they progressed further north. At the 3,350 ft. level north of Oriental shaft much better results had been obtained. Immediately to the north of the big east and west dyke they now had a practically continuous run of good ore ground extending for 435 ft. in length. The value of this ore-body had been about 1 oz. 2 dwt. per ton over widths of from 1½ to 2½ ft. In Kennedy's section the winze near the shaft had been sunk from the 3,800 ft. level to 25 ft. below the 4,000 ft. level in good ore for the whole distance, averaging 2 ft., assaying 18 dwt., and improving to 2 ft. 8 in. worth 1 oz. in the last 45 ft. sunk. The 4,000 ft. levels north and south had been commenced from this winze, which was the deepest working on the lode in this mine, and for the 28 ft driven the reef had averaged 3 ft. in width, assaying 1¾ oz. At the 3,650 ft. level this ore-shoot had a length of 638 ft. and at the 3,800 ft. level of 362 ft. There was thus shown a diminution of length at the deeper level, but as development proceeded at the 4,000 ft. level it was hoped that matters would improve again. The reserves were now estimated to stand at 202,300 tons, and showed a decrease of 500 tons for the year. The electrically operated hoist at Oriental shaft had continued to do good work throughout the year, as also the new one at Richards'. The ore milled was 102,731 tons, of an average assay-value of 15 dwt. 4 gr. per ton. The slime treated was 74,351 tons. The cost per ton of ore mined and treated in 1918 was £1. 7s. 6¾d., as against £1. 6s. 5½d. in 1917. This was exclusive of development charges, which amounted to £47,500, as against £44,400 last year. The pre-war figures for the year 1914 showed costs, excluding development charges, amounting to £1. 2s. 11d. per ton mined and treated, an increase, due to war conditions, of 4s. 7½d. per ton. Of this, 2s. 4½d. per ton was due to the rise in exchange. A position which was causing some concern had arisen during the past few months in regard to the water supply and the food supplies for the native population. With regard to the former, the situation would be alleviated by a timely rainfall in the neighbourhood of the drainage area of the Betamangalam tank, and they were awaiting news from India in this respect. The food supply question had received prompt attention, and as every precaution had been taken by their officials in India, it was hoped the difficulties had been removed.

To summarize the position, they would agree that, having regard to the fact that the gold production for last year, in spite of the adverse conditions existing, was only 829 oz. below that of the previous year, the record for 1918 must not be regarded with dissatisfaction from the mining point of view.

The resolution was unanimously adopted.

OOREGUM GOLD MINING CO. OF INDIA, LTD.

Directors: Malcolm Low (*Chairman*), Sir J. D. Rees, Lt.-Col. Sir Donald Robertson, John Taylor, Edgar Taylor, Robert Taylor. *Managers*: John Taylor & Sons. *Secretary*: F. H. Williams. *Office*: 6, Queen Street Place, London, E.C. 4. *Formed* 1880. *Capital issued*: 481,544 ordinary shares and 240,000 preference, both of 10s. each.

Business: Operates a gold mine in Kolar district, Mysore State, South India.

The ordinary general meeting of the Ooregum Gold Mining Company of India, Ltd., was held on April 8 at the Cannon Street Hotel, London, E.C., Mr. Malcolm Low (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for 1918, said that the results of the year's operations, though substantively good, were not so good as they were in the year 1917. The tonnages dealt with were: at the mill 152,780 tons, and at the cyanide works 205,438 tons, showing respective decreases of 2,300 tons and nine tons as compared with the results of the year before. The yield of gold per ton milled was 4·9 grains higher and that per ton cyanided was 3·4 grains lower than the figures for 1917. The total amount of gold obtained was 89,631 oz. against 90,687 oz. the year before, showing a decrease of 1,056 oz. After deducting royalty due to the Mysore Government, the gold realized £358,837, and the total income of the year was £366,007. The expenditure was £222,224, leaving a profit of £143,782. There were two amounts written off, namely, £15,000 for depreciation and £9,471 on account of the circular shaft, while £5,000 and £1,000 were transferred to reserves. Interim dividends paid in October last absorbed £48,677, and the year ended with a disposable balance of £60,955, which would admit of a final dividend of 1s. 6d. per share on both classes of shares. The dividends for the year would, therefore, be 3s. 6d. per share, or 35%, no the preference shares, and 2s. 6d. per share, or 25%, on the ordinary shares. While they must regret the drop of 6d. per share in the dividends, they would have found little difficulty in laying their finger upon the cause. It was essentially, of course, increased working costs. These totalled £222,234, against £199,252 in the year before, showing an increase of very nearly £23,000. No less than £10,800 of this £23,000 was due to the increased rate of exchange which prevailed during the year. The remaining portion of the increased costs was due to unavoidable increases in the prices of material and freight, and also to war bonuses and increases of wages and salaries necessitated by the times.

Mr. John Taylor seconded the motion.

Mr. Edgar Taylor then gave details of results at the mine. The reserves of ore now stood at 392,690 tons, having decreased 22,093 tons on the previous estimate. This decrease had been anticipated, as it was known that a good deal of dead driving would have to be done to pass through the zone of ground so seriously disturbed by cross-courses in Bullen's section to the north. He might safely repeat what was said last year, namely, that stoping would undoubtedly reveal a considerable quantity of ore between these cross-courses. In Taylor's section the shaft was sunk to the 59th level and the 58th level was driven north and connected with Oakley's. This section was full of possibilities, but there was nothing of importance to record for the past year. In Oakley's section the shaft was sunk to the 60th level. A level north at that depth had been commenced and should soon reach the rich shoot seen at the levels above. They had that day heard by mail that at this horizon in the northern drivage from the winze below the 57th level, which had reached the 60th level, the lode was a foot and a-half in width, assaying 11 dwt., and in the south drive it was a foot and a-quarter wide, assaying 14 dwt. The 59th levels north and south from this shaft totalled 147 ft. in length on reef 2 ft. wide, assaying 19 dwt. per ton, and the value had increased, the lode in the north level being a foot and a-half wide, assaying 1 oz. 5 dwt. This was highly encouraging, not only for this mine but for the field in general. The level next above, the 58th, had developed reef $1\frac{1}{4}$ ft. in width worth 1 oz. per ton over a length of 452 ft. The very good assay of 2 oz. 5 dwt. had lately been obtained here. Oakley's section, therefore, continued, on the whole, most promising. The shoot when first discovered higher up had but a short length, but it now showed distinct signs of lengthening out and of opening up a substantial tonnage of ore reserves. In Bullen's section the shaft was sunk 273 ft. to 38 ft. below the 60th level. The reef had steepened considerably at the depth now attained, and the shaft was being sunk at an angle of 75° from the horizontal. At the 58th level north and south the zone disturbed by the cross-course, already mentioned, was encountered. 581 ft. were driven at this horizon and, although the reef made its appearance at intervals, no estimate of ore ground could yet be made. At the 57th level north a drive was commenced from the second winze, and for the short distance driven, 18 ft., the quartz averaged $3\frac{3}{4}$ ft. in width, assaying $\frac{1}{2}$ oz. per ton. In the south end the reef was 6 ft. wide, assaying 1 oz. 2 dwt., and in the north end 5 ft. 9 in. wide, assaying 12 dwt. The 56th level north was continued during the year. At this horizon the reef was in close vicinity to, and sometimes cut out by, the cross-course, but for an aggregate length of 330 ft. the reef was clearly defined, varying in width from $1\frac{3}{4}$ to $2\frac{1}{2}$ ft. and assaying from 13 dwt. to 1 oz. 4 dwt. per ton, and the latest news of the increased width and value at these important points was very gratifying. The 55th and 54th levels north were also continued until the large east and west dyke was encountered close to the north boundary. At these last two levels good reef assaying 1 oz. per ton, and over, was encountered for an aggregate length of 400 ft., the width varying from 2 ft. to $5\frac{3}{4}$ ft. The circular shaft, somewhat to the north of Taylor's shaft, but of course a long distance to the west, was sunk 260 ft. and is now 332 ft. deep. Oakley's and Bullen's shafts had reached the 60th level, which was 5,419 ft. vertically below surface. At this depth ventilation became a difficult and important matter, but with the assistance of the fans installed at the 50th and 55th levels, the lower levels of the mine had been kept well ventilated, and there was a better circulation of air through the stoping sections. With a view to further improvement of the natural ventilation they were enlarging the upper part of Wallroth's shaft, which was an upcast, and had converted the vertical portion from rectangular to circular bricked form. These improvements would probably suffice until such time as the new circular shaft reached the 32nd level.

The motion was carried unanimously.

JIBUTIL (ANANTAPUR) GOLD MINES, LTD.

Directors: Capt. W. B. McTaggart (*Chairman*), Lt.-Col. Sir Donald Robertson, Vere H. Smith, John Taylor, Arthur E. Taylor, Lord Vaux of Harrowden. *Managers and Consulting Engineers:* John Taylor & Sons. *Office:* 6, Queen Street Place, London, E.C.4. *Formed* 1911, reconstructed 1913. *Capital issued:* £25,000 in preference shares and £211,232 in ordinary shares, both of 10s. each.
Business: Owns a gold mine in Anantapur district, Madras Presidency, India.

The sixth ordinary general meeting of the Jibutil (Anantapur) Gold Mines, Ltd., was held at the offices of the company, 6, Queen Street Place, London, E.C., on March 20, Mr. Vere Herbert Smith presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended September 30 last, said that 18,200 tons of ore was treated, the extraction of gold therefrom being 5,722 oz. of fine gold of a value of £24,266. The total expenditure was £32,616, and the receipts £24,562, resulting in a loss of £8,054. In the month of October last the final clean up of the reduction plant was effected, which realized 450 oz. of fine gold worth £1,905. Since December, 1913, when crushing commenced, 128,570 tons of ore had been treated, yielding 35,816 oz. of fine gold, of a value of £152,662. Small profits were made in 1915, 1916, and 1917, but in the year under review a loss occurred of £8,054, as mentioned, notwithstanding the fact that the average extraction for that year was 6 dwt. 6 gr. of gold per ton, which was the highest obtained in any year. This unfortunate result was chiefly attributable to the greatly increased costs of materials and stores and the unfavourable exchanges which prevailed for remittances of money to India, and other adverse factors arising out of war conditions. In a circular dated October 30 last, the directors informed shareholders that as the general conditions affecting the work of the mine had become increasingly difficult, it had been decided to suspend all mining work. In a further communication to the shareholders, dated December 3 last, the board intimated that they had requested Mr. C. H. Richards, the superintendent of the Nundydroog mine, to visit the Jibutil property, and advise upon the prospect of the mines being successfully reopened, in the light of the recent developments. Mr. Richards expressed the opinion that there was not sufficient hope of permanent and improved values in the ore-bodies recently worked to warrant the expenditure necessary to reopen the mines. No. 1 Prospect shaft centre was one of the points referred to by Mr. Richards as holding out promise, and showing a decided improvement in the 400 ft. level. The directors and managers considered that further work should be undertaken at this centre, when the general conditions became more favourable.

Mr. John Taylor seconded the resolution, and it was carried unanimously.

DOLCOATH MINE, LIMITED.

Directors: Frank Harvey (*Chairman*), Oliver Wethered (*Vice Chairman*), R. Arthur Thomas (*Managing Director*), James M. Holman, F. A. Robinson, F. W. Thomas, F. W. Janson. *Secretary:* J. F. Odgers. *Office:* Camborne. *Formed* 1895. *Capital:* £350,000; debentures £75,000.
Business: Operates a tin mine at Camborne, Cornwall.

The twenty-fourth annual general meeting of Dolcoath Mine, Ltd., was held at Salisbury House, London, E.C.2., on March 26, Mr. Oliver Wethered presiding.

The Chairman, in moving the adoption of the report and accounts for the half-year ended December 31, said that the ore crushed was less by 4,067 tons as compared with the previous half-year, but that the tin obtained per ton showed an increase of 2·48 lb., so that the tin actually sold was only 20 tons less. The price realized showed an increase of 4s. 11d. per ton, but unhappily the costs reached the unprecedented figure of £2. 7s. 9d. per ton, compared with £1. 3s. 10d. for the last complete half-year before the war. The diminished output meant a greater ratio of standing charges. The tonnage for the last half-year was less than half that of the last complete half year before the year, and 12% less than that of the first half of 1918. He hoped and believed that they had reached the lowest point of output, and that their returning miners would help to restore the fortunes of the old mine. The cost of materials must in a very large number of cases be reduced. They would watch with interest the effect of the amalgamation of practically all the explosives companies, looking for a large reduction in the prices. A most important question was the cost of coal used for power and in calcining. In 1914 the cost for coal and electrical power was 3s. 10d. per ton of ore, and for 1918 it was 10s. 4d.

Mr. F. A. Robinson seconded the motion.

Mr. R. Arthur Thomas, managing director, said the present position due to increase in costs could be met in two ways. In the first place they must get more production, and it was most essential that they should get more production per man. With an increased production of tin-stuff, costs per ton would naturally diminish, as Dolcoath's standing charges bore a heavy proportion to the total expenditure. In the second place, the question was: what chances were there in the mine for future development? On the previous occasion, he indicated the view that there was no pronounced chance in Dolcoath of discovering large tonnages of tin-stuff capable of restoring it to its former pre-eminent position; but there were unexplored areas which could be developed and which would be more in the nature of compensating advantages than big discoveries, which would enable them to hold the present position. He also mentioned some ground to the north, and there were the North and South Roskear setts, which had been attached to Dolcoath. When these lodes, which had been extremely profitable in the killas, were developed in the granite, he personally looked forward to a large and profitable production of tin. He would, however, be wanting in his duty if he did not point out that very large sums of money would be required to properly explore and develop these mines. They were giving great attention to this matter and had been for some time past engaged in formulating an engineering scheme for the purpose.

The motion was carried unanimously.

KWALL TINFIELDS OF NIGERIA, LTD.

Directors: H. G. Latilla (*Chairman*), E. H. Eldridge, J. P. Rowe, S. S. Briggs. *Secretary:* W. M. Campbell. *Office:* Finsbury Pavement House, London, E.C. *Formed* 1912. *Capital issued:* £41,755 in 5s. shares.

Business: Development of alluvial tin properties in Nigeria

The ordinary general meeting of Kwall Tinfields of Nigeria, Ltd., was held on April 9 at River Plate House, Finsbury Circus, London, E.C., Mr. H. G. Latilla (the Chairman of the company) presiding.

The Secretary (Mr. W. M. Campbell) having read the notice convening the meeting and the report of the auditors,

The Chairman said: I do not think the accounts require much explanation. As you are aware, the capital has been increased to £100,000 by a resolution passed at an extraordinary meeting of shareholders held on June 12 last. You will remember that at that meeting I hinted at a possible bonus as a result of the sale of a portion of our properties. Solely owing to the Treasury embargo a deal was impracticable. At the same meeting I also made a promise that shareholders would be given an opportunity of subscribing to the new issue at par. Many shareholders availed themselves of this opportunity, and as a result 75.455 shares have been taken up and have been issued since the date of the accounts The balance of the new issue —that is, 125,545 shares—have also been issued since that date in part satisfaction of the new properties acquired by the company. It will be seen from the accounts that the issued capital as at the date thereof was 198,020 shares, upon which the sum of £43,305 had been paid. A further sum of £5,000 has since been received upon the 31,000 additional shares issued. The total issued capital of your company at the present date is 398,680 shares of 5s. each, amounting to £99,670. It will be within your recollection that the new area acquired, which I dealt with pretty exhaustively at the meeting at which its acquisition was approved, consists of exclusive prospecting licences over an area of 28 square miles adjoining the company's property. You company has, however, under the same arrangement, acquired something in addition to these exclusive prospecting licences which I was not in a position to tell you about at the meeting held in June—namely, a 30% undivided interest in a silver-lead property. You will all desire to hear about this new discovery. At the moment I cannot give you a great deal of information for two reason, firstly, because we have not yet received Mr. Cousin's full report, and, secondly, because we are busily engaged in adding to our properties, for which purpose a second expedition has been fitted out. What I can tell you, however—and for this my authority is Mr. Cousin—is that there seem to be vast deposits of silver-lead and zinc blende. Ore-bodies can be traced for over 50 miles. The ore-bodies are of good width and average assays of samples so far received show ore contents of roughly £20 sterling per ton, or the equivalent of, say, 5 oz. of gold. Mr. Cousin also states that the conditions for cheap working and transport are excellent. I might, perhaps, usefully add that the interests in this discovery are held as follow: Kwall Tinfields, 30%; Transvaal and Rhodesian Estates, 30%; Union and Rhodesian Trust, 30%; and original prospectors, 10%. You will be kept informed of developments, and I only hope that Mr. Cousin's strongly expressed views as to the great possibilities will be borne out by results. We are negotiating with one of the leading engineers —until quite recently holding the important position of consulting engineer to the Burma Corporation—and shall hope to arrange for a full report by him. If this is satisfactory, as may properly be expected, there will be no difficulty in arranging for such funds as the business may require.

As stated in the report, the profit for the period was £4,451. 18s. 2d., which, taking into consideration the increased cost of all material, stores, etc., consequent upon the war, is, I think, a satisfactory result. To the profit of £4,451. 18s. 2d. the balance as per last accounts—namely, £130. 17s. 7d.—has to be added, making a total of £4,582. 15s. 9d. From this amount the percentage of profit accruing to the directors—namely, £222. 11s. 10d.—together with £3,205. 18s. 3d. being the amount absorbed by the interim dividend of 6d. per share (less tax) declared on July 3 last, has to be deducted, leaving £1,154. 5s. 8d. to be carried forward. Tin ore appears in the accounts at £33,243. 11s. 5d. of which £25,334. 8s. 3d. has been realized, and £7,909. 3s. 2d. is the estimated value of tin in course of transit.

With regard to our tin ground, Mr. Cousin advises us that, although for reasons stated in the directors' report our monthly outputs have been poor, particularly having regard to the considerable amount spent on the property, we may expect regular returns for years to come in accordance with his original forecast. Given these returns, and allowing for even a big drop in the price of tin, we should be able to earn and pay you good dividends on our capital. While what is likely to come to us from the silver-lead may represent something very handsome, obviously I cannot attempt to submit any figures. On the known facts we are, I think, entitled to expect big things, as this may well prove the most important mineral discovery of recent years.

As intimated in the report, Mr. J. M. Iles has relinquished his appointment as advisory-engineer. We have, however, been fortunate enough to secure the services of Mr. H. F. Hueston, who is the manager of Ex-Lands Nigeria, Ltd., in his place. Mr. Hueston has been asked to make a full report on the property, and immediately the same is received it will be communicated to the shareholders.

I have very little more to add, except that you will probably recollect that we got into the bad books of the Treasury because we made our issue without permission, and that the Stock Exchange consequently struck our shares out of the list. An application has been made to the Stock Exchange for reinstatement. Dealings, as you are probably aware, take place in the shares, I think, fairly heavily; many thousand shares have been changing hands each day, but that is not quite the same as having our shares marked in the list, and I, for one, shall be glad to have them reinstated. I think, also, that we shall be entitled to have a settlement in the new shares, for which some of you subscribed at par last year.

Mr. E. H. Eldridge seconded the motion, which, in the absence of question or comment, was carried unanimously.

The appointment of Mr. S. S. Briggs to a seat on the board was confirmed, and the retiring director, Mr. H. G. Latilla, was re-elected.

CHAMPION (NIGERIA) TIN FIELDS, LTD.

Directors: S. R. Bastard (*Chairman*), F. N. Best, John Waddington *Consulting Engineer in Nigeria:* R. W. Hanam. *Secretary:* A. J. Culley. *Office:* Friars House, New Broad Street, London, E.C 2 *Formed* 1909. *Capital:* £50,000 in shares of 5s. each.

Business: Development and finance of Nigerian tin properties.

The eighth ordinary general meeting of the Champion (Nigeria) Tin Fields, Ltd., was held on April 7 at Winchester House, London, E.C., Mr. Segar R. Bastard (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, said that, with regard to the position of the company and its holdings in subsidiary companies, there was very little fresh to report. Since the field re-opened in Nigeria at the beginning of the year they had acquired certain interests, but he had received no detailed particulars, and could not say anything very definite about them. As far as he could gather, their manager had obtained an area east of Jos and another near Naraguta Extended. They had also secured an E.P.L. over two square miles on which three mining rights had been taken up, and their manager was negotiating for the purchase of further rights. Their gold property consisted of two square miles and one E P.L., on which they had taken up three mining rights, and they were interested with another syndicate in a further mining right. In addition to this they had recently despatched another expedition, particulars of which he did not wish to disclose, but which he was sure had great prospects. This was not actually in Nigeria, but it was in West Africa. It would be a large proposition if they acquired it. Particulars would be communicated to the shareholders as soon as possible. They had acted drastically, as regarded the balance sheet, in writing off what they had been spending on the gold properties. They had, therefore, not erred on the side of over-estimating the values of the shares they had in other companies. They had realized further shares, and had a considerable amount of cash in hand, with which they would be able, if circumstances warranted, to do further business. With regard to their subsidiary companies, the Berrida had acquired an interest in a Cornish mining property called the Poldice, where they had been at work for over 16 months. They had experienced much delay in obtaining the requisite plant, but he looked upon the prospect there as exceedingly good. The Naraguta Extended continued to be a good producer; the Tin Fields of Nigeria had acquired a new property, and was a very good company; and the Lucky Chance Mines, in which they had a large holding, had a large interest in Berrida, so that there was a good prospect with regard to their interests in these companies.

Mr. Frank N. Best seconded the resolution.

Mr. Wood said that the shareholders had every confidence in the board, who, he considered, were managing the company in a very satisfactory manner. It appeared to him from the figures that they had liquid assets to the amount of £61,062 and liabilities which were practically only £7,044.

The resolution was carried unanimously.

MUREX COMPANY, LIMITED.

Directors: G. P. Joseph (*Chairman and Managing Director*), D. Anderson, E. Spyer. *Secretary:* W. Weir. *Office:* 1, London Wall Buildings, London, E.C.2. *Formed* 1913. *Capital:* £86,643. 5s., in 5s. shares.

Business: Owns the Murex magnetic separation patents; has recently been producing tungsten.

The sixth ordinary general meeting of the Murex Co., Ltd., was held on March 17 at Salisbury House, London, E.C., Mr. George P. Joseph (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1918, explained the causes which had led to the reduced profits. There was an increase of £3,000 in the amount of interest paid, owing to the action of the Ministry of Munitions in not relieving the company of its stocks. During the greater part of the past year the company was making profit at a considerably larger rate than in the previous year. Before the new issue of shares was made, the board obtained from their general manager a report on the current operations and an estimate of the profits being earned, which showed that these would be sufficient on the increased capital not only to maintain the rate of dividend paid in the previous year but to increase it. Except for the fact that about this time a certain amount of high-speed steel, which had been manufactured for Russia, was returned, there was no reason to anticipate that that rate of profit would not continue to the end of the year, and no cause to anticipate that there would be an almost complete cessation for the demand of tungsten such as followed the signing of the armistice. During one of his visits to Sheffield he came to the conclusion that all manufacturers of tungsten were not being treated on the same basis. It was subsequently discovered, as the result of discussions with the Ministry, what he and other manufacturers had suspected, namely, that one firm of manufacturers had not only been receiving more ore than it ought to have done under the arrangements made by the Ministry, but that it had had the whole of its output allocated to steel manufacturers during the latter months of the year, when other manufacturers were only having a proportion allocated. In addition, it had since been admitted that the firm in question—whether with the cognizance of the Ministry or not he was unaware—had for some time been selling its products at a net price lower than the official price laid down by the Ministry, and to which price all the other manufacturers had adhered. He thought that what he had stated was in itself sufficient to account for the unsatisfactory results of the company's trading operations. The directors had no intention to allow matters to rest where they were.

Mr. Edmund Spyer seconded the motion, which was carried unanimously.

ANGLO-PERSIAN OIL COMPANY, LIMITED.

Directors : Charles Greenway (*Chairman and Managing*) Admiral Sir E. J. W. Slade, Sir Hugh S. Barnes, J. T. Cargill, D. Garrow, James Hamilton, F. W. Lund, H. E. Nichols, Lord Southborough, F. C. Tiarks, R. I. Watson, Sir T. R. Wynne. *Directors appointed by the Government :* Lord Inchcape, Sir F. W. Black. *Secretary :* F. Macindoe. *Office :* Britannic House, Great Winchester Street, London, E.C. 2. *Formed* 1909. *Capital :* £2,000,000 in preference shares and £3,000,000 in ordinary: debentures £2,400,000.
Business : Works oil properties in Persia and refines the oil.

The ninth ordinary general meeting of the Anglo Persian Oil Company, Limited, was held on March 26 at Britannic House, Great Winchester Street, London, E.C., Mr. Charles Greenway (Chairman and managing director) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended March, 31, 1918, said that the trading profit amounted to the very satisfactory sum of £1,516,994, after making ample allowances for depreciation, as against the conservative estimate of not less than £800,000 to £1,000,000 which he gave when dealing with the previous year's accounts. A substantial portion of this profit was due to the earnings of their fleet, for a portion of which during the year under review they were able to find very remunerative employment. They had out of their profits paid off the advances of £175,547 made by the Burmah Oil Company in their early days to enable them to pay the preference share dividend guaranteed by them and also the sum of £45,843 due to them for interest thereon. They had also written off the whole cost of their last preference share and debenture issues, and allocated a total of £330,000 to various reserve accounts. This left a balance of £779,708, out of which they had paid dividends amounting to 8% per annum on the preference shares, and they now recommended the payment of a similar dividend on the ordinary shares. The balance remaining to be carried forward would be £454,722, which would amply suffice to cover the amount payable in respect of excess profits duty. With the various extensions already on the way the throughput of their refineries would within the next year or two be trebled, and other extensions which they hoped to arrange for in the near future should, when completed, bring their throughput up to five times or six times the quantity dealt with in the year under review. They anticipated no difficulty in finding markets for this largely increased production. Their only difficulty was to provide refining, transport, and storage facilities fast enough to meet the demand for their products. They had practically an unlimited supply of crude oil, and with the great increase in the demand for oil products of all kinds resulting from the enormous development of motor traction in every part of the world, and for fuel oil as a substitute for coal for steam-raising and other purposes, there was endless scope in the direction of the sale of their products ; but the laying of additional pipe lines, the building of further refineries and tank vessels, the erection of the great number of large storage tanks required at their fields, refineries, and distributing installations to meet the constantly increasing throughput, and all the other engineering work connected with an undertaking such as theirs, was a slow process, particularly under present unfavourable conditions, both as to supply of material and labour, and consequently it would be several years before they could hope to reach the maximum figure of throughput indicated.

Apart from the large quantities of fuel oil which they had been supplying throughout the war for the use of the Navy, they had been supplying the War Office with practically the whole of the requirements of the Mesopotamian Expeditionary Force for railway, motor, and other transport. How far the Mesopotamian expedition had tended to bring about the successful conclusion to the war he would not venture to express an opinion, but, notwithstanding the attacks which were at one period of the war made on "side shows," it was generally admitted now that had this expedition not been undertaken the position in the East to-day would have been very different.

The field work carried on lately further confirmed the opinions previously held as to the great productivity of their fields. The wells in the field from which they had hitherto been obtaining their production still maintained their extraordinarily high rate of yield, and the wells already drilled were, it was estimated, capable of yielding a production at the rate of 5,000,000 tons per annum. On the field adjacent to it, another well, at a distance of about one mile from the preceding one, had struck oil in considerable volume, the well being reported upon as being equal to any yet struck in the company's territories. In the third field little progress had since been made, owing to the lack of drilling material, but the prospects were still satisfactory. Testing operations were being carried on, or were about to be started, in a further six fields, all of which gave promise of favourable results. The first of the refinery extensions at Abadan had recently been completed and brought into operation. The further extensions, for which capital was issued a little over 12 months ago, had not yet been completed, owing to the great delay which had been experienced in obtaining delivery of plant, but they were now well in hand, and should be completed during the year. A further large addition at Abadan had now been decided upon to meet the rapidly growing demand in the East for fuel oil, and would be undertaken as soon as plant could be contracted for at reasonable prices and delivery. In addition to the extensions at Abadan, they had commenced the erection of a large refinery near Swansea, where the refining of such products as were marketable in the United Kingdom could be carried on more thoroughly and more economically than at Abadan. The initial capacity of this refinery would be twice that of the whole of the Scottish shale oil companies.

Additional pumping stations were now in course of erection, and should be in operation during the course of this year. They had also decided upon the laying of an additional 10 in. line from the fields to their present 8 in. line, in place of the present 6 in. line, which would further considerably augment the pipeage capacity between the fields and the Persian Gulf. They would, when this line was completed, have one complete 10 in. line from the fields to the Gulf, and another line made up of 10 in. pipe for about half the distance and 8 in. for the remainder.

Sir Frederick W. Black seconded the motion, and it was carried unanimously.

TOUGH-OAKES GOLD MINES, LTD.

Directors : G. R. Bonnard (*Chairman*), R. Simpson, E. H. R. Trenow. *Secretary* : F. Almond. *Office* : Balfour House, Finsbury Pavement, London, E.C.2. *Formed* 1914 *Capital issued* : £230,007.

Business : Holds a controlling interest in a Canadian company of similar name, operating a mine in the Kirkland Lake district, Ontario.

The adjourned fourth ordinary general meeting of the Tough-Oakes Gold Mines, Ltd., was held on April 7 at Salisbury House, London, E.C., Mr. G. R. Bonnard (Chairman of the company) presiding.

The Chairman said the directors' report stated that the complicated litigation in which the company had been involved for some years past, had at length been satisfactorily settled in accordance with the terms of settlement unanimously approved by shareholders at the extra-ordinary general meeting held in October last. At that meeting they were told that after such settlement had been carried through the assets of the company would be represented by about 415,000 fully-paid shares of $5 each in the Canadian Tough-Oakes Gold Mines, Ltd., and liquid assets and cash to the value of approximately £10,000. The settlement had worked out with a better result than was anticipated. They had 426,843 shares in the Canadian company, instead of 415,000, an increase of 11,843 shares, and the liquid assets in the shape of their holding in the Kirkland Lake Proprietary Company and the Sudbury Syndicate, together with cash at bankers, represented a realizable cash value of approximately £105,000, as against the £100,000 anticipated. As a result of the settlement, they had secured the practical control, development, and working of the Tough-Oakes mine, and funds had been provided to discharge all the debts and obligations of the Canadian company and gave it a clear £30,000 in cash as further working capital. They had secured the services of Lieut.-Colonel H. H. Johnson, D.S.O., as consulting engineer, and he had been examining the property. They had recently received a cable from him stating that he thought highly of its prospects, and that development work had been recommenced under his advice and directions. He also, in effect, informed them that such work in the past had, in his opinion, been ill-conceived and badly carried out. Now, however, that they had obtained full control a stop once and for all had been put to such a condition of affairs. The prospects for this mine under the new management were excellent. Lieut.-Col. Johnson was examining other adjoining mining properties with a view of possible amalgamation with theirs

An announcement had been made in Canada that, satisfied that traffic and other conditions warranted such an undertaking, the Ontario Government had officially announced its intention to build a railway to Kirkland Lake. Not only would this be a benefit to the present producing mines of that district, but it would also be a boon to the large number of mining prospects which lay in close proximity to the proved mines.

Mr. Robert Simpson seconded the resolution, and it was carried unanimously.

SOUTH AFRICAN DIAMOND CORPORATION, LTD.

Directors Bernard Oppenheimer (*Chairman*), Isaac Lewis, S. Marks, G. S. Ronaldson, C. F. Rowsell, J Van Praagh *Head Office* : Lewis & Marks Building, Johannesburg *London Office* : Halton House, 20/23 Holborn, London, E.C. *London Secretary* : E. J Jenkinson. *Formed* 1913 *Capital issued* 2 permanent directors' shares of £1,000 each, and £98,000 in ordinary £1 shares.

Business Deals in diamond properties in South Africa, and is interested in the Blaauwbosch, Pneils, New Vaal River, New Thor, and Roberts Victor ; has holdings in Brakpan, Springs, and Rand Selection Corporation.

By order of the Court separate meetings of the holders of permanent directors' shares and of the holders of ordinary shares of the South African Diamond Corporation, Ltd. (Transvaal), were held on April 9 at the First Avenue Hotel, Holborn, London, E.C., for the purpose of considering and, if thought fit, approving with or without modification a scheme of arrangement proposed to be made between the said company and the holders of the permanent directors' shares and the holders of the ordinary shares in the said company. Mr. C. F. Rowsell presided.

The Secretary (Mr. E. J. Jenkinson) having read the notice convening the meeting of the holders of permanent directors' shares,

The Chairman said : I know that the two permanent directors, who form a separate class in this company, are present or represented by proxy. I therefore declare that this meeting is properly constituted. I now move that the scheme of arrangement be adopted by he permanent directors.

The resolution was then put to the meeting and carried unanimously.

The Secretary next read the notice of the meeting of ordinary shareholders.

The Chairman said : I have in my hands proxies for 32,658 shares, and I therefore declare this meeting properly constituted. The meeting has been called under the direction of the Court for the purpose of approving a scheme of arrangement with the permanent directors. I need not, I think, elaborate that scheme, first, because you have all had it in your hands for some time past, and, secondly, because your Chairman, Mr. Bernard Oppenheimer, at our last meeting very fully explained the whole of the details. I think I need only refer to the two main points in the scheme. Under the original memorandum of association of the company the permanent directors' shares had (*a*) the right to have divided between them in equal shares 25% of the profits of the company in each year after the allocation to reserve of such a sum thereout as the directors shall determine ; (*b*) the right to receive in equal shares 25% of the surplus assets in a winding up after payment off of the whole of the paid up capital, including the capital paid up on the permanent directors' shares. There are other provisions which are being dispensed with, but those are the two most important. The consideration which is being given by the company to secure the consent of the holders of the permanent directors' shares is the right within the period of 5 years from the first day of January, 1919, to call upon the company to allot to the permanent directors 50,000 ordinary shares of the company of £1 each, as to the first 25,000 shares so called at 25s. a share, and as to the remaining 25,000 shares at 30s. a share. Such options may be exercised from time to time as such holders or their legal personal representatives think fit. Those are, I think, the main and essential points of the scheme of arrangement, and as the whole of the proxies which I hold have been placed in favour of the scheme I think it is pretty clear that the proposal, which is, in my opinion, entirely favourable to the company, and which will enable it to raise capital with very much greater ease, has been approved by the shareholders as a whole.

Before moving the adoption of the scheme of arrangement by the ordinary shareholders, I might mention for your information that the company up to the present time has had a very prosperous year. Our profits will, I think, exceed those of the corresponding period of last year, and there is every prospect of these good results continuing. With these few words I will now move that the scheme of arrangement as submitted to you and explained by me be approved, and I will ask Mr. Malcolm to second that.

Mr. J. Malcolm: I have much pleasure in seconding the adoption of the scheme of arrangement.

The Chairman: Before putting the resolution to the meeting I will ask whether there are any questions which any shareholder would like to put to me on the subject, or whether anyone has any observations to make upon the proposal.

No question being asked the resolution was put and carried unanimously.

The proceedings then terminated.

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.Sc., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone: *London Wall 8938* Telegraphic Address: *Oligoclase* Codes: *McNeill*, both Editions

BRANCH OFFICES: [illegible] Market Street, San Francisco; [illegible] Fisher Bldg., Chicago

SUBSCRIPTION: U.K. and Canada, 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.).

Vol. XX. No. 5 LONDON, MAY, 1919. PRICE ONE SHILLING

CONTENTS.

EDITORIAL

IN the list of Honours published at the end of April are the names of Mr. Charles Greenway, chairman of the Anglo-Persian Oil Company, who becomes a baronet, and of Professor R. A. Gregory, editor of *Nature* and organizer of the British Science Guild's exhibitions, who is created knight.

JAMES WATT will have been dead a hundred years on August 25. Birmingham, where most of his work was done, is taking steps to commemorate this event. No foolish statue is to be erected, but a professorship of engineering at the University is to be endowed, and a museum is to be built for the reception of early engineering relics.

IN our March issue, Mr. E. P. Hollis, in writing of the possibilities of small hydro-electric installations, gave particulars of a plant of this character in Yorkshire. He should have stated that this plant was designed and erected by the General Electric Company, Ltd., of London, the firm who, as our readers are aware, recently acquired the business of Fraser & Chalmers.

THE appointment of Major W. M. Henderson-Scott to the secretaryship of the Imperial Mineral Resources Bureau is a matter of congratulation to all concerned. He had a brilliant career at the Royal School of Mines from 1904 to 1907, taking the associateship in mining in the first class, and the De la Beche medal, while his war services have proved him an energetic organizer.

IN a recent issue of *Chemical and Metallurgical Engineering* the editor points to the evil results arising from the interference on the part of boards of governors composed of politicians and similar ignoramuses with the curricula and staffs of technical colleges. This is a real grievance, and has worked much harm at many centres of education in the United States. For instance, the continual resignation of professors and teachers at the Colorado School of Mines is notorious and the underlying scandal calls loudly for redress. But this type of grievance is not confined to professors. Editors, both in America and this country, often experience the same disadvantage when their papers are owned and controlled by syndicates, the members of which often have little or no interest in or knowledge of the matters in hand. The editors of certain daily papers on both sides of the Atlantic often have an anxious and uneasy time of it and never know when the proprietary whirlwinds will unseat them. The technical press in America knows several of these syndicates of ownership. Though the journals published by these houses are prosperous and highly useful, the personal influence in their columns gradually wanes, and men of experience and judgment find the editors' chairs unattractive.

PUBLIC announcement with regard to the future of the Imperial College of Science and Technology will be made shortly. The College is to be raised to the status of a University with power to confer degrees, and the chief disadvantage accruing from not being united with London University is to be removed by an agreement between the two universities that will prevent overlapping and duplication of courses of study. The University of Technology is also to have close relations with other universities and teaching centres. We have on several occasions referred to the advantages to be gained by a closer connection with Camborne Mining School, but the teaching staff at the Royal School of Mines have gone further and have desired a working arrangement with colleges in the Midlands or the North where instruction in coal mining and in the mechanical and power problems of mining may be studied. These proposals have been adopted and will form part of the new scheme. Thus the future of the Royal School of Mines and of the Imperial College is now on a fair way to final and satisfactory settlement.

A NEW departure in technological teaching has been taken by the authorities at the Royal School of Mines by the inauguration of a series of extra lectures on current topics of interest in the mining and metallurgical world, delivered by experts in their particular subjects. The primary object of establishing this course was to provide men who had been at the war an opportunity of studying the chief new developments in mining and metallurgical practice during the past five years. The lectures, however, have a wider function, for they are free and open to every one desirous of acquiring information. The course started on May 1 and the lectures already given were on zinc smelting by Mr. J. C. Moulden, of Seaton Carew, on sulphuric acid manufacture, by Mr. Raymond Curtis, and on mineral flotation, by Mr. H. L. Sulman. Other lectures will be delivered by Mr. H. F. Marriott, on the Francois cementation process, by Mr. H. K. Scott, on modern methods of iron mining in the Midlands, by Dr. F. H. Hatch, on recent iron ore developments in the United Kingdom, and by Colonel F. D. Adams on the development of mining in Canada during the war. Professors Frecheville and Truscott are to be congratulated on the success of the new venture, and we hope that it will be developed into a permanent feature at South Kensington.

OPINIONS differed as to the desirability of changing the name of the American Institute of Mining Engineers to the American Institute of Mining and Metallurgical Engineers, so members were asked to decide for themselves between the relative claims of conciseness and comprehensiveness. In the event, 1,274 were for the change and 672 against, about 40% of the members taking part in the voting. The other question recently before the council once more, namely, the proposal for the absorption of the Mining and Metallurgical Society of America, has again been postponed. The committee who had the matter in hand reported favourably, and it was generally supposed that the proposal would be accepted and the anomaly of having two societies thereby removed. At the last minute, however, something prevented the completion of the negotiations, and the difficulty remains unsolved.

The Institution.

Last month a special and unusually interesting meeting of the Institution of Mining and Metallurgy was held at Burlington House, Piccadilly, when a paper was read by Major H. Standish Ball, entitled "The Work of the Miner on the Western Front, 1915 to 1918." The attendance was easily a record, and late comers experienced great difficulty in securing standing room. The meeting was followed by an informal dinner at the Monico restaurant, where the discussion of the paper was continued. The lecture was illustrated by a series of excellent lantern slides, many of which are reproduced in printed form in the published paper. Major Ball served as Assistant Inspector of Mines at G.H.Q., France, and was occupied largely with instruction work. The paper is far too long for reproduction in our pages, so we advise readers to buy copies, the charge for which is 5s.

On May 8 the annual meeting of the Institution was held. The report of the council for the past year reveals the fact that under the altered circumstances of the times the expenditure has outstripped the revenue. The cost of printing and of administration has steadily advanced, while at the same time the receipts from members' subscriptions have fallen, owing partly to deaths at the war, and partly to the decrease in accession of new members. These adverse conditions relating to membership are, however, only temporary. In order to remedy the position as regards finance, the council has taken two steps whereby the income may be increased. In the first place, members and associates who were elected before 1908 have been invited to pay the present rate of yearly fees. In the early days, the full members paid £2. 2s. 0d. per year and the associates £1. 11s. 6d. In the year mentioned the scale for new members and associates was raised to £3. 3s. 0d. and £2. 2s. 0d. respectively. In response to this invitation, 377 members and 307 associates have voluntarily agreed to pay the higher rate. This is a difficulty that often faces a society or other association, in that the election to membership usually implies a continuity of the rate of subscription holding good at the time, and a council, committee, or majority of members cannot legally cancel the old contract and raise the rates. On the other hand, some societies expressly provide for such a contingency, and one of our younger and virile societies expressly bargains that the subscription may be varied from year to year in order to meet requirements. It is certainly an illogical position that some members should be forced, through no fault of their own, to pay more than others. If membership is worth £3. 3s. 0d. to one man, it is worth the same to another, and the old member, though he may agree to pay more now, can still congratulate himself that on an average over his life he is paying less than the new member. Old stagers should also recollect that membership of a chartered professional society is worth far more than that of a voluntary association. As a matter of grace, if not for self-advantage, all members should have agreed to the higher rates at the time of the granting of the Charter.

The second source of new income to which reference is made is the establishment of an advertisement section to be added to the monthly bulletin. Many professional societies, sometimes perhaps rightly, consider the appearance of advertisements in their transactions and other publications to be inadvisable and even objectionable. For ourselves, we have no prejudices against advertisements, and we cannot imagine that any fault can be found in connection with the step taken by the council.

The presidential address delivered by Mr. Hugh K. Picard was well worthy of the Institution and of metallurgical science. Mr. Picard reviewed the progress in non-ferrous metallurgy during the past five years, and not only presented a useful résumé of information already published, but told something of work hitherto done in secret owing to war conditions. For instance, he briefly discussed the separation of lead and zinc by the brine process. He also said that at the projected Avonmouth plant it was intended to use Delplace hand-operated roasting furnaces in place of the modern mechanical roasters. We hope he will give the reasons for this decision on a subsequent occasion. Space forbids further quotation from his address, but we shall revert to the subject again next month.

American Patent Reforms.

Last month we discussed the many weak points of the English patent law, and suggested several modifications in practice and methods. A committee, of which Mr. Justice Sargant is president, is now advising the Government on the subject, and the situation is considered hopeful. Some of the advocates of reform in this country have referred to the superiority of the United States patent laws from the inventor's point of view. But the Americans are conscious of certain failings in their present system, and a number of improvements are desired. There are, in fact, a great many points in connection with which alterations might be proposed. In order, however, to avoid the mistake of appearing to ask for too much, and thus confuse the issue, the agitation is to be taken by instalments, and the proposals now before the public are limited to four in number. In the first place, it is suggested that a special court of appeal should be created, to sit at Washington, and that appeals from the judgments of district courts should go to the new court instead of to one of the nine circuit courts of appeal as at present. Such a rearrangement of procedure would remove the anomalies caused by various courts of appeal giving different judgments on the same patents, and it would give the advantage of providing a court well versed in inventions. The second proposal is that the Patent Office should be an independent institution, and not a bureau of the Department of the Interior. It is claimed that the standing thereby given to the Patent Office would enhance the respect of both Congress and the public for the office and for the inventor. Thirdly, higher scales of pay for the examiners are demanded in order to attract men of scientific and technical skill. The present salaries are much the same as they were in 1848 when the Patent Office was established, and the principal examiners receive only \$2,700, or about £550 per year, which is obviously inadequate. The fourth proposal is in connection with results of litigation. When an inventor has won his case against an infringer, his troubles are not necessarily ended, for the judgment seldom helps him in the collection of royalties or damages. The relative influence of the invention on the saleability of the article or the success of the process is difficult to decide, and for this reason the inventor may fail to recover any money from the infringer. The proposal now put forward provides that the court shall adjudge the damages or the royalty. The committee that has prepared these suggestions was appointed in 1917 by the National Research Council, at the request of Mr. Thomas Ewing, then commissioner of patents, who had the approval of the Secretary of the Interior in taking the step. Mr. Ewing served as commissioner for four years, and had previously been an examiner for thirty years. He was one of the members of the committee, and other members were Messrs. L. H. Baekeland and M. I. Pupin, scientists and inventors, Messrs. W. F. Durand, R. A. Millikan, Reid Hunt, and S. W. Stratton, scientists, and Messrs. J. P. Fish and E. J. Prindle, patent lawyers, all of them competent men and held in esteem. Their proposals are founded on justice, and deserve acceptance by the United States Government.

The West Country Metal Output.

We referred very briefly last month to the first issue of the year-book of the Cornish Chamber of Mines. Owing to its publication just as we were going to press, it was impossible to do full justice to it, or to quote the statistics which the Editor, Mr. H. E. Fern, has collected. In a recent issue we complained that the Government had recently been suppressing detailed statistics of output, though the sum totals by county were still published. Mr. Fern has been fortunate in securing the missing figures for the years 1914 to 1917, and to give promptly complete returns for 1918. In the consideration of the tin output of Cornwall and Devon there are two factors which usually upset calculations unless their existence is known and allowance made for them. In the first place, only about 60% of the output of tin concentrate is sold at the fortnightly ticketings at Redruth, the remainder being sold by private treaty. Secondly, the outputs of concentrate reported by the mines represent about 80% of the total output, the other 20% being the yield of the stream-tin works, where tailings from the mines are re-treated, in some cases many times over. The metallic tin content of the stream concentrate is not in the same proportion, as the material is of much lower grade than the first concentrate from the mines. In the following table are given the figures for the outputs at the mines for 1918:

	Sold at Ticketings Tons	Output Tons
Basset (Redruth)	301	318
Bedford (Tavistock)	—	22
Botallack Bottoms (St. Just)	16	—
Cornwall Tailings (Carn Brea)	—	156
Dolcoath (Camborne)	819	827
East Pool (Carn Brea)	1,280	1,280
Geevor (St. Just)	—	418
Giew (St. Ives)	—	180
Grenville (Camborne)	448	451
Hemerdon (Plympton)	2	2
Levant (St. Just)	238	278
Magdalen (Perranwell)	7	24
Peevor (Scorrier)	5	9
Pendeen (St. Just)	6	6
Porkellis (Wendron)	—	45
Porthledden (St. Just)	1	—
Progo	1	—
South Crofty (Carn Brea)	564	581
South Polgooth (St. Austell)	—	19
Tincroft (Carn Brea)	382	379
Trencrom Hill	5	—
Tresavean (Redruth)	—	311
Wheal Bellan	17	—
Wheal Kitty (St. Agnes)	—	62
	4,094	5,368

It will be seen that there are 19 producers, while five other names are found in the list of sellers at the ticketings. The table, of course, does not give the output of the stream-works, which, not being mines, are not obliged by law to publish their figures. It will be some months before the Government estimate for their output can be supplied, and in the meantime the total output of tin from all sources for 1918 will not be known. There are one or two apparent discrepancies in the table, for some mines report sales but no output, and in the list of sales at the ticketings the name "Progo" appears. There is no such mine known in the West Country, so possibly the shipment came from abroad.

In glancing through the table it becomes at once apparent that a number of important mines are not selling at the ticketings. The Geevor, near St. Just, produced 418 tons during 1918 and sold it all by private contract. The Tresavean follows with 311 tons, the Giew with 180 tons, and Cornwall Tailings with 156 tons. Smaller amounts came from Wheal Kitty (62 tons), Porkellis (45 tons), Bedford (22 tons), and South Polgooth (19 tons). To get an idea of the relative figures during a year for which complete returns are available, we may turn to the figures for 1917. During that year 43 mines produced 5,261 tons of concentrate and the total output of tin concentrate was 6,576 tons, so that the stream works accounted for 1,315 tons of low-grade material. Of the total mine production 4,186 tons was sold at the ticketings. Comparison between the results for 1917 and 1918 shows that 24 small producers have recently dropped out.

Mr. Fern has also collected statistics of the output of arsenic, wolfram concentrate, and copper concentrate. These we reproduce in the following table:

	Arsenic Tons	Wolfram Conc. Tons	Copper Conc. Tons
Basset	—	0.2	—
Bedford	197	5	—
Dolcoath	169	—	—
East Pool	441	57	—
Castle an Dinas		46.5	—
Hemerdon	—	10	—
Tresavean	14	—	563
Levant	52	—	55
Peevor	—	0.2	—
South Crofty	562	72	—
South Polgooth	4	—	1.75
Tincroft	484	32	
	1,563	222.9	620.75

Simplified Spelling.

During the last two years the Simplified Spelling Society, and other bodies and individuals having the same object in view, have renewed their attempts to reorganize English spelling. Several of these reformers have asked us for our support of their propaganda, and have invited us to use our endeavours to promote the cause in one way or another. Lest, by the nature of the foregoing introduction, some of our readers may fear that we intend to disfigure the Magazine by weird and unaccustomed spellings, we may say at once that no scheme of reform so far promulgated receives our support, even in theory, let alone in practice. No one denies that English spelling is full of absurdities, irregularities, and exceptions to the rule. It is true that there are forty or more elementary sounds and only twenty-six letters, of which three are unnecessary, and that many sounds have therefore to be represented by combinations of letters and the same letter has to do duty for several different sounds. The first difficulty presented to the student who examines the various proposals for reform is that the authorities differ as to the actual number of different sounds. Next we find that no two proposals agree as to the method of representing the various sounds by the letters of the present alphabet. For instance the unpronounced "r" is retained for the purpose of modifying the pronunciation of a preceding vowel; and no difference in spelling denotes the difference in pronunciation of "ng" in "singer" and "linger." Then, again, there is the difficulty of determining the standard pronunciation of each word, and in this respect the vowels in particular give much trouble. Simplified spelling is supposed to facilitate the teaching of the language because by its means the eye and the ear are brought into line, but when dialects are considered it will be found that the sounds will be nearly as far from simplified spelling as from orthodox spelling. Thus we are brought to the fundamental fact that our heritage of illogical spelling is due not so much to the bad speller as to the faults of pronunciation. Still another objection to any scheme of simplification is the entire absence of proposal to indicate the accent. Surely the child or the foreigner should be guided in some way between, for instance, "dev'elop" and "devel'op." In the absence of accents the pronunciation of each word would have to be learnt individually just as at present.

The English language is a composite one, and is derived from many sources. Words denoting the simplest of ideas come mainly from the Saxon. Subsequently other words were introduced from France. The influence of the Normans was two-fold. One was to eliminate or modify the rougher sounds of the Saxon language, thus giving rise to such absurdities as "cough, bough, and though." The other was to graft on to the English language a number of words of Latin source carelessly pronounced and ignorantly spelled. The modern words indicating more delicate shades of meaning are borrowed mostly from Latin. These are all easy to pronounce and easy to spell. During the Middle Ages education was at a low ebb. Few could read and write, and both spelling and pronunciation roamed unmolested. In Germany there was less intermingling of languages and reciprocal influence on pronunciation, so that the German language preserves its old spelling and pronunciation, which remain consistent. Nor has the German language gone to any great extent to Latin and Greek for its philosophical and scientific terms. They call nitrogen "stickstoff" (that is choke-stuff), and build up long words with perspectives on them, as Mark Twain used to say, to denote complicated ideas. The German language meets the demands of the advocates of spelling reform, but in spite of its logical construction, it has little chance of being the universal language. And while speaking of other languages, it may be said that French is more in need of reform in spelling and pronunciation than English, yet every one acknowledges it a charming language, full of poetry and sentiment.

The question in dispute with regard to the system of spelling resolves itself into the relative superiority of sight or sound as a means of recording ideas. There is no accurate method of recording and reproducing sounds. The ear is not so keen to recognize a sound and to retain and transmit the memory of it as the eye is to comprehend and perpetuate a word or a drawing. The eye aids the ear more than the ear aids the eye. The reformers disdainfully draw attention to the fact that the sound represented by "no" is spelled this way and also "know." This, in our view, is just where the eye can help the ear. Where there are words of similar pronunciation it is an advantage to have a variation in spelling, just as it is where words of identical spelling but of different meaning may have varying pronunciations.

The final query put to us is: Why do you recommend a reform in weights and measures yet object to spelling reform? The answer is that the advantages of the metric system are obvious and have been proved in practice in other countries and by the scientists here, while any proposal made so far in the cause of spelling reform does not meet the case fully and makes confusion more confounded. The only logical way of starting a real reform of English spelling would be to introduce a new alphabet of forty or more letters. Anything less is in the nature of a compromise, and as the present system is also a compromise, a change on these lines is not obviously advantageous. The eventual solution of the language difficulty will probably grow from a universal-language germ, of which Esperanto is a favourable specimen. Such a language would be logical in every respect, besides being elastic and capable of expansion. In each country the universal language would be taught in addition to the home language, and the universal language would be the language of interchange between nations, just as Latin used to be among scientists and theologians until a century ago. The school curricula would be simplified by the elimination of the many courses in foreign languages, and that would make up for some of the time now lost, according to the reformers, in learning English. Some readers may think the universal language a long way off, but a month or two ago they thought the same of the League of Nations. Anyway, it is near enough to make the reform in English spelling not worth while, even if it were not inadvisable for other reasons.

REVIEW OF MINING

Introduction.—The Allies' peace terms were handed to the German delegates on May 7, the fourth anniversary of the sinking of the *Lusitania*. Germany is given fifteen days to decide whether to sign the agreement or not. Politically and economically, the terms are crushing, and either force or some sort of aid may be necessary in order that they shall be carried into effect. It is possible also that re-arrangements of the territorial proposals may yet be made, especially in the north-east of Germany. As regards mineral deposits, France is to have the Saar coalfields on lease, and the zinc district of Upper Silesia is handed over to Poland. Other notable events of the month are the continuation of the Sankey Commission, which is now inquiring into the nationalization of coal mines, and the freeing of the silver market from control in England and America. The probability is that silver will remain at a high price for a long time, and attention might well be turned to silver mining.

Transvaal.—The labour position has shown some signs of improvement, but a good deal of unrest continues. In some quarters objection has been raised once more against recruiting north of latitude 22°. The Government is about to establish a mint at Pretoria. No coining has been done in South Africa since President Kruger's days. The new step should be beneficial to local trade and international commerce. The decision of the Supreme Court to the effect that the Provincial Governments can tax mining profits as well as the Union Government will have the effect of adding to the financial burden of the mines. It is understood that New Modderfontein, the company which undertook the test case, will appeal to the Privy Council.

The reports for 1918 of the companies controlled by the Johannesburg Consolidated show that the chief prosperity of the group is in the Far East Rand. At the Government Areas, the reserve is estimated at 9,445,000 tons averaging 8 dwt. per ton, as compared with 7,016,000 tons averaging 7½ dwt. the year before. The steady advance in tonnage and content during the last four years is very marked. During the year, 1,303,500 tons was milled, yielding gold worth £2,162,584. The profit was £880,535, out of which £369,982 was paid as the Government's share, and £385,000 was distributed as dividend, being at the rate of 27½%. At Van Ryn Deep the reserve is estimated at 2,445,759 tons averaging 9 dwt. Here again the reserve has shown a steady increase in amount and content during the last four years, though not to the same extent as at Government Areas. During 1918, 530,550 tons of ore was milled yielding gold worth £1,163,005. The profit was £535,300, and £538,601 was distributed as dividend, being at the rate of 45%.

Of the mines of the Johannesburg Consolidated group in the older parts of the Rand, Consolidated Langlaagte has to report a further fall in output and profit. The ore milled was 503,300 tons and the yield £633,022, as compared with 585,650 tons and £728,945 the year before. The profit was £159,231, and £47,500 was paid as dividend, being at the rate of 5%, as compared with £228,553, £166,250, and 17½% the year before. The reserve is estimated at 2,103,000 tons averaging 6·2 dwt., as compared with 2,132,778 tons averaging 6 dwt. per ton the year before. Shortness of labour is the chief cause of the present adverse position. At Langlaagte Estate the developments were encouraging during the year. Gold worth £647,999 was extracted from 523,690 tons of ore. The profit was £128,105, out of which £110,812 was paid as dividend, being at the rate of 12½%. The results at the Witwatersrand Gold (Knight's) were not good owing to shortness and inefficiency of labour, and also to the low grade of development and reclamation ore. Developments at the lowest levels have recently been encouraging. At the Randfontein Central, 1,745,000 tons was milled, yielding gold worth £1,991,838, while the cost was £1,883,766. The reserve was estimated at 4,254,000 tons averaging 6·8 dwt., as compared with 5,185,000 tons of the same content the year before.

The disposal of enemy shareholdings in Transvaal mines proceeds. The Modder Deep company has purchased approximately 70,000 shares from the Custodian of Enemy Property, at £6. 12s. 6d. per share. Of these, 23,810 will be distributed as dividend, while the remainder will be offered for sale at the same price to shareholders, in the proportion of one share to every ten shares held. In the case of the Geduld, the number of shares involved is about 250,000, and the price paid was £2. Of the total, 85,185 will be distributed as dividend, and the remainder offered to shareholders, in the proportion of two for every eleven held.

The Geduld has started the sinking of a new rectangular vertical shaft at a point about 2,500 ft. from the southern boundary and approximately equidistant from No. 3 main incline and the intermediate incline. Both of these inclines have been driven considerable distances during the past year. The new shaft is expected to be about 2,500 ft. deep.

As readers are aware, the development of West Springs is being conducted by drives from Springs until two new shafts reach the ore. No. 1 shaft had been sunk 90 ft. when a serious subsidence occurred. The conditions are such that it is deemed best to start again at a new place. Bore-holes were put down with the object of finding the exact position of a very hard and wide dyke, the presence of which had been ascertained. From the information obtained by the bores, it has been possible to place the new shaft in a position where sinking will be more rapid and economical.

The two engineering societies of South Africa, the South African Institution of Engineers and the Chemical, Metallurgical, & Mining Society of South Africa, are arranging for the holding of an exhibition of machinery and appliances manufactured locally as an outcome of the war.

Cape Province.—The deposits of nitrate of potash between Prieska and Griquatown, north of the Orange River, are to be worked by a corporation just formed for the purpose. The nitrate is found in shale, in quantities ranging from 3 to 10%. The shale is to be milled and leached.

Diamonds.—The South-West Diamonds, Limited, has passed to the control of the Consolidated Gold Fields. The company was originally formed to dredge in the neighbourhood of Possession Island, which is a British possession off the coast of German South-West Africa. More recently it has acquired areas at Kolmanskop and Pomona, where the dry sand was sifted by German companies.

A company called Makganyene Diamonds, Ltd., has been formed to work a kimberlite deposit on a farm of this name, 140 miles west of Kimberley. A trial plant, consisting of crusher, rolls, and two pans, has been started. It is said that the diamonds are of good white colour. Mr. T. G. McLelland is the managing director and engineer.

Rhodesia.—Though the Globe & Phœnix has won its case against the Amalgamated Properties, and there is therefore no longer any need for secrecy, the periodical reports continue to be of the scantiest. The report for 1918 tells that the output of gold was £343,171, and the net profit £114,065. The shareholders received £120,000, being 3s. per 5s. share, free of income tax. During 1917 the output was £403,370, and the dividends £266,666. The reserve is calculated at 159,913 tons averaging 29·4 dwt. per ton, as compared with 184,053 tons averaging 28·9 dwt. the year before. Mr. D. P. Macdonald has recently gone to Rhodesia in connection with the copper and other properties, for the development of which the Phœnix Mining & Finance Co. was formed last year.

West Africa.—In our March issue we referred briefly to the Winnebah tin deposits belonging to the Appollonia Gold Fields, Limited. We are now able to announce that the Ashanti Goldfields Corporation has taken a working option on these deposits. A brief summary of the reports on these properties, made by Messrs. Innes, Macdonald, & Seale, has been issued by the Appollonia company. The area acquired is known as the Mamkwadi, and covers 100 square miles. The prospecting work so far done is on ground that stretches from the coast near Appam for a couple of miles inland. The country rock is a hornblende schist intersected by pegmatite dykes. The region is covered with grass and low bush, with hills a few hundred feet high rising abruptly from the plain. The first discovery of cassiterite was in a creek, and as most of it showed little signs of wear by water, search for lodes was undertaken concurrently with trial of the gravel by pitting. The first lode to be found is about a quarter of a mile east of the creek, and was exposed during pitting. At first the lode appeared to be a hundred feet wide, but, on sinking, it was found that the surface deposit was only a sill or capping of smaller dykes. Further information as to the nature of the capping will be of interest, for it may be what Mennell calls a spread enrichment, an eluvial deposit, or a surface flow of igneous rock. Two of the dykes have been followed downward for 20 ft. or so, 8 and 2 ft. wide respectively. Other dykes have since been found, and several alluvial deposits have been tested. The opinion expressed by the engineers is that in a large number of places the deposits are rich, but that the distribution of the tin contents is irregular. It is the number of rich pockets that will determine the payability of the dykes. The engineers and the directors of the company are to be congratulated on their cautious attitude with regard to the width of the lode on the surface. What a fine opportunity there would have been for a conscienceless promoter!

Nigeria.—The Northern Nigeria (Bauchi) Tin Mines is about to issue £75,000 preference shares for the purpose of meeting the cost of the hydro-electric station at Kwall Falls. The contract for this installation is in the hands of

Vickers, Limited, and the work is already in progress.

The Keffi Tin Company has doubled its capital by the issue of 200,000 new shares of 5s. each, all of which have been subscribed. These funds are to be devoted partly to the provision of additional plant for the Amari property in the Nassarawa district (described in our issue of November last), and partly to the purchase of new interests. An exclusive prospecting licence over four square miles on the Bauchi plateau has been secured, and shares have been bought in the Kuru Syndicate. This syndicate owns a property on the Bauchi plateau which has just started producing, and it is under the same management and control as the Jantar Nigeria Company.

Australia.— The position at the copper mines in Australia is becoming serious owing to the stagnant state of the metal market. It is reported that all the mines except Mount Lyell and Mount Morgan have closed down. At Mount Morgan no copper produced since October has as yet been sold and the payment of the usual dividend has been postponed. In all probability the labour position has also been a factor in the case, at any rate in Queensland. There is another labour trouble at Broken Hill. As regards the zinc position, the British Government is being held to its contract with the Australian Government to buy concentrates for ten years. How to dispose of these concentrates is the trouble, for they are not liked by British smelters. The big works planned at Avonmouth, near Bristol, by Mr. R. Tilden Smith, who formed the National Smelting Company for the purpose, were never completed. In any case smelting could not have commenced during the war because delivery of raw material could not be effected. Under peace conditions, labour cannot be obtained for the works, so Mr. Tilden Smith has had no alternative but to abandon the project. A suggestion has been made that the Belgians should handle the Australian concentrates, but we understand that this class of material is not particularly desired by the Belgian smelters. As the Government is financially committed in connection with these works, perhaps it will change the name from "National" to "Nationalized" and undertake the smelting itself.

At the Ivanhoe mine, Kalgoorlie, the campaign of development initiated by the new general manager, Mr. John McDermott, is giving good results, and in spite of the fact that no more ore is found in depth, the total reserves have been maintained. At the end of 1918 the reserves were estimated at 1,000,209 tons averaging 34s. per ton, as compared with 1,035,874 tons averaging 34s. 2d. the year before. Mr. McDermott knows the mine well, having been underground manager at a period some time previously to his appointment as general manager. The new lode has responded to development, but shows signs of impoverishment in depth. In addition to the reserves mentioned, large amounts of high-grade ore have been disclosed in the east branch lode, but measurements cannot yet be made.

The Amalgamated Zinc (De Bavay's) announces that the contract to treat North Broken Hill zinc tailing expired on April 30, and that the plant lately employed on this tailing is now being used on dump material already in the possession of the company and paid for. The contract with Broken Hill South will expire on December 31. Notice has been given to the Junction mine that the contract will be suspended because the deliveries are not being made according to contract as regards quantity, grade, and degree of fineness of crushing.

Antarctica.—Another exploring expedition to the Antarctic continent is being organized. The leading spirit is Mr. John L. Cope, and he calls it the British Imperial Antarctic Expedition. The famous *Terra Nova* has been acquired. Mr. Cope is an experienced antarctic traveller and was surgeon and biologist with the Ross Sea party in 1914-17. Among the plans is one for mineral prospecting, but, judging by the list of minerals mentioned in his list, the staff does not apparently yet include a mining man or geologist.

Burma.—One of the first public offers of mining investments since the withdrawal of Treasury control was in connection with the Burma Queensland Corporation. This company was formed to acquire 98% of the shares in Tavoy Concessions, which owns the Hermyingyi wolfram mines, and also to purchase the Wolfram Camp and Mount Carbine wolfram-molybdenite-bismuth mines in North Queensland, which have recently been brought to a producing stage. Messrs. R. Tilden Smith and A. F. Maclaren had this promotion in hand. The public have been invited to buy £225,000 debentures in the Burma Queensland Corporation, the property of the National Metal & Chemical Bank, Mr. Tilden Smith's holding company. The mines and properties are admittedly important ones, but with the chief demand for wolfram gone, there is no attraction to buy shares or debentures in a company in this line of business. As the promoters were able to certify that no part of the proceeds of the issue was to be applied for capital purposes outside the United Kingdom, the present Treasury restrictions did not apply. Otherwise the Treasury would have been well advised to exercise its powers of veto. The advertisements of the issue gave the profits of Tavoy Concessions for the past two years, and estimates of the expected profits of the Queensland properties and Tavoy properties in the future. The recent and present profits are high owing to the Government buying wolfram at 60s. per unit, but within six months of Peace this price will disappear. In the meantime the Government offers its stocks in the market at 30s. It is little use estimating profits on a basis of pre-war prices, for wolfram was always difficult to sell and the market shaky.

Malaya.—Mr. James Wickett was in excellent form when presiding at the annual meetings of his group of Malayan tin companies last week. The Gopeng, though 27 years old, is still a big producer, and will continue to be so for many years yet. The Tekka-Taiping is a more recent venture, and war conditions have prevented its expansion. During the next year or two a great increase will be seen in its scale of operations. At Pengkalen a tract of low-lying ground has been proved suitable for treatment by bucket-dredge. Rambutan is doing well as a mine, and also as a supplier of current to adjoining operators.

Scotland.—Boring for oil was started recently under Government control in the West Calder district of Midlothian, a place noted for its oil-shales. From time to time in the past free petroleum has been found, but never in large quantities, and bores have indicated the presence of petroleum on several occasions, though no flow ever resulted.

Canada.—The Kirkland Lake Proprietary Co. is issuing 25,000 additional shares, the price of issue being 37s. 6d. These shares are being offered to shareholders in the proportion of one share to every four held. The underwriters take a commission of 5s. per share, and have an option on a further 25,000 shares up to March 31, 1919, at 45s. per share. The final settlement in connection with the amalgamation with the Tough-Oakes and other adjoining properties will not be long delayed.

United States.—The appeal in the case of Minerals Separation *v.* Butte & Superior with regard to the meaning of "a fraction of 1% of oil" was heard by the Supreme Court at Washington in March. Judgment is not expected for some time. We gave particulars of this case in our issues of October, 1917, and July of last year.

Pulverized coal can now be mixed with oil in such a way that it will not settle, thus presenting the characteristic of a colloid. This composite fuel was developed by the American Navy under the superintendence of Mr. Lindon W. Bates, an oil engineer who will be remembered in London as being associated with Mr. H. C. Hoover. The coal is pulverized until 95% will pass 200 mesh. The fuel consists of 45% oil, 20% tar, and 35% coal, together with about 1% of a "fixateur," the composition of which is not disclosed.

Mexico.—President Carranza is recommending a modification of the constitution relating to the holding of petroleum lands. The specific proposals are not yet given, but their object is to "consolidate the sources of national wealth according to the law of equity, destroy special privileges, and place Mexicans and foreigners on the same footing." Details are awaited.

Spain.—Last month we mentioned that the Cordoba Copper Company's mines were to be closed temporarily owing to the uncertainty of the copper position. The directors now announce that negotiations are in hand for the sale of the property as a going concern.

Colombia.—The Oroville Dredging Co. has issued encouraging cables relating to the Constancia mine, to which reference was made in our last issue. The profit for April is reported at $5,000, though the equipment is antiquated and of low efficiency. The Colombian Government has recently removed the tax on mining machinery. The district where the mine is situated has been worked for some time, and contains a number of lode-gold mines. Recently it has attracted the attention of American engineers, and several properties have been acquired by United States capitalists.

Bolivia.—At the meeting of shareholders in Aramayo Francke Mines, some details of output were given for the last completed financial year of the company, ended May 31, 1918. During this period the output of tin concentrate was 1,845 tons, and of wolfram 188 tons, obtained from 36,606 tons of ore, showing a yield of 5½% per ton. During the same time the sales of tin and wolfram concentrates were 1,607 tons and 210 tons. The sales of copper matte were 180 tons, and of cement copper 65½ tons. The silver sulphide concentrate sold contained 300,132 oz., and the picked silver ore 209,602 oz. Figures for the bismuth output are not given, but we may remind readers that the company is one of the big producers of this metal. The Chorolque tin mines give poor results in depth. On the other hand the Chocaya mine is opening up further reserves of tin-silver ore.

THE COPPER INDUSTRY OF THE SOUTHWEST:

ARIZONA, NEW MEXICO, AND CHIHUAHUA.

By W. TOVOTE, E.M.

The "Southwest" is the biggest copper-producing region in the world, and contains many famous mines such as the Copper Queen, United Verde, the U.V.X. Miami, Inspiration, Ray, and Chino. The author has a wide personal knowledge of the region and of its geology.

INTRODUCTION.—The days of the Argonauts of 1849 had passed into history. Virginia City had blazed as a comet. The receding tide of gold seekers had opened the treasures of the Rocky Mountains. But between Texas on the east and the California coast on the west, and bounded on the north by partly explored country containing the mining camps of Colorado, the Mormon domain of Utah, and the wonderful Nevada mines, lay the Great Desert, which was at a later date to become the "Empire of the Southwest."

Wagon tracks of the fortune hunters had scarred it, the flotsam of failure had dropped along their lines, the pioneers, in victory or despair, had drifted back, and the Indian was still supreme. True, the patient Mexican had long ago followed the lead of the Conquistadores into this, their Farthest North, but he had merely settled along the few fertile bottom-lands. The last of the Confederates of the Civil War had found a defiant asylum here and erected a mock-banner of Secession, long after the matter at issue was dead. The thrifty Mormons had trecked in from the north and spread thin oases of orchards and green fields along far-spaced river valleys, but the country at large was only a dreaded stretch of horror and deprivation, separating the famed Golden West from the blood-bought independence of Texas.

Mining was the magic wand that has opened the Southwest in the last quarter of the nineteenth century. The lure of bonanza and sudden wealth made the pioneer brave the burning desert, the trackless mountains, slow death from want of water, and sudden death from the silent arrow of lurking Apaches. It was silver in those days and sometimes gold. Copper was without value and neglected. But the steel rail followed the prairie-schooner and the pack-burro. Civilization stretched out tentacles into the land, where rope and six-shooter were the supreme law. When the precious metal bonanzas were on the wane, the despised red metal began to claim attention.

Santa Rita, New Mexico, where the Chino Copper Co. now has obliterated the burrowings of the gambucino, saw the earliest copper-mining. Copper in native form or reduced in adobe furnaces had been freighted from here into Mexico long before the coming of the Eastern adventurer: but this did not lead to important mining operations until comparatively recently. The first real copper camp

[illegible] Canyon near Morenci [illegible]

that sprang into existence was what is now the Clifton-Morenci district in Arizona. Soldiers, chasing a band of Apaches, are said to have discovered masses of native copper on the limestone slopes above Chase creek, where now is the Longfellow mine belonging to the Arizona Copper Company of Edinburgh.

News of the discovery spread to Silver City, N.M., at that time the most flourishing settlement in this unknown land. Mexican miners answered the call, and the Lescinsky Brothers, merchants whom the silver harvest of Chloride Flats had started on the road to wealth, furnished the first capital. There followed at intervals during the next few years the discoveries at Globe and Bisbee, and later that at Jerome.

From these beginnings the copper industry of the Southwest rose during two decades from a gambling hazard to a business of world-wide importance; and now, barely 45 years since the first copper-prospect was started, Arizona alone produces more copper annually than did the entire world a few decades ago or the United States 15 years ago, and stands unchallenged as a producer by any other state of the Union or any other country in the world.

The mining centres and ore deposits, which have contributed to this success and which will be reviewed in this paper, are as follows:

Arizona:

The country of the "Coconine Beds."
Jerome, the Mayer district, and Prescott.
The Pinal mountains area (Globe).
Clifton-Morenci.
Tucson and vicinity.
The Dragoon mountains.
Bisbee.
Ajo and the desert counties.

New Mexico:

The "Red Beds."
San Pedro.
Santa Rita.
The Burro mountains.
The Organ mountains.
Oro Grande.
Lordsburg.

California:

The desert country of Southeastern California.

Sonora:

Cananea and Nacozari.

The names above will appear like a motley assortment to those casually acquainted with the Southwest. Some districts are of actual prime importance, while others have come and gone, and again others are still doubtful factors. But the mining industry is transitory; it has its to-day as well as its yesterday and to-morrow. Its day is measured in years sometimes, and again in decades or centuries, but it is a limited space of time; more limited now in this age of intensified industrial exploitation than ever before.

This mining territory, extending from New Mexico into California and from Colorado-Utah border into Sonora, covers an area 750 miles east-west and over 400 miles north-south, or quite an empire in itself, according to European standards. The population of this territory numbers about half a million people, or less than two to the square mile, indicating that there is a lot of elbow-room left. There are other industries besides mining, such as cattle raising, farming, ranching, and lumbering. There is furthermore the great amount of capital and energy invested in railroading and transport.

GEOLOGY.—The Southwest shows four great eras of sedimentation and three principal periods of igneous activity. Deep sea and continent reigned here in turn, and the change from one to the other opened vents for the forces of vulcanism, held in leash while the outer lithosphere was in equilibrium and quiescent.

Upon an Archean ocean followed the oldest continent. The Paleozoic saw again the sea dominant, which receded at a period near the beginning of the Mesozoic era, only to sweep back with one mighty but short-lived stroke in Cretaceous time. The end of the Tertiary indicates oscillations of a rising and disappearing continent. While Archean sediments and very old granitic rocks underlie probably the entire territory, they are exposed now predominantly in its western part. Going east the remnants of Paleozoic sediments recur more and more frequently, usually culminating with the Carboniferous in Arizona, but including Permian strata in New Mexico. Superimposed appear islands of Cretaceous sediments, which might at one time have covered the entire Southwest, but every trace of which has disappeared from large sections. The end of the Tertiary and the early Quarternary brought vast accumulations of littoral and lacustrine deposits, reflecting the contemporaneous rising of the present continent and the catastrophic subsidence of the Carribean Sea.

Triassic and Jurassic strata are found only in the northernmost part of this territory, linking it with the geological provinces to the north.

Besides the dim volcanic record of Archean time, igneous activity was most forceful during the change from ocean to continent toward the end of the Cretaceous period, and again synchronously with the oscillations of late Tertiary and Quarternary age.

The oldest volcanic rocks are in their present exposures mostly granitic in texture and

Map showing the Copper Regions of the Southwest

massive in form. The Mesozoic intrusions are principally porphyritic and are found in dykes and stocks; while the youngest igneous rocks, after working their way upward as dykes and volcanic funnels were spread out over the surface as flow after flow of lava beds.

All these agencies, those of sedimentation as well as vulcanism, have left their imprint over the entire Southwest. Still there is noticeable a gradual increase of the younger members over the older ones in going from west to east. As the more recent geological formations are not favoured by ore deposition—manganiferous deposits are the only ones of present economic importance that I have found in Quarternary rock—this gradual disappearance of the older rocks below recent cover accounts to some extent for the decline of mining activity toward the plains of eastern New Mexico and Texas.

But this is not the only reason. The main force of mineralization follows the contraction ridges of the Rocky Mountains and Sierra Nevada from the north down to the Sierra Madre in Mexico, and on to the Cordilleras of South America. It reached a maximum of intensity twice, first in late Cretaceous time, and again in the Tertiary era. The imprints of these two periods cross and recross each other and complicate the ultimate picture. The former, the Mesozoic period of ore deposition, is predominantly the age of copper deposition in the Southwest, with which we are concerned principally. Its course can be traced from Utah and Nevada through central and eastern Arizona and western New Mexico and on down through Sonora. Of less actual importance are the copper deposits of Tertiary age, but their day is dawning, while the romance of their bonanza days has been written on the early pages of precious metal mining in the Southwest.

Operating Companies.—The tendency of copper mining has been its centralization in the hands of a few big companies. Where to draw the line between big and lesser corporations is a puzzling problem. A few measure their output by the 100,000,000 lb. standard; others in multiples of 10,000,000 lb.; others, even though they exceed 1,000,000 lb. per month, are considered small in Arizona mining parlance; while individual operators, producing 1,000,000 lb. per year, are big men in their part of the field.

The copper interests are linked so much all over the United States and South America, that groups that are not of great importance as actual producers in the Southwest, are really more influential people even there than others whose local production is considerably higher.

The following three companies or groups are the biggest producers:

1. The Phelps-Dodge Corporation (Copper Queen, Moctezuma, etc.).

2. Calumet & Arizona (Cole-Ryan interests, Inspiration, Cananea, etc.).

3. Daniel C. Jackling interests (Chino and Ray).

These represent three different chapters of the history of the Southwest. The Phelps-Dodge Corporation is one of the pioneer operators and dates back to 1880; the Calumet & Arizona infused new enterprise when mining threatened to become stagnant around 1900; and Col. Jackling's rise to wealth and fame is connected with the advent of the "Porphyries," the great low-grade deposits which have monopolized the public interest for the last ten or twelve years until the discovery of the phenomenally high-grade deposit of the United Verde Extension turned the popular fancy to the search for such bonanzas. This last great discovery has been fully as important as the rise of the porphyries, not as a producer but as a stimulus to renewed interest in mining and prospecting, demonstrating again what wonderful returns can be derived from successful mines. This effect would have been far greater and more general had not the entrance of the United States into the War demanded the diversion of funds from prospect and uncertain development work into channels of greater immediate need.

The above three companies produce each more than 150,000,000 lb. of copper every year.

The production of the following ranges from 25,000,000 lb. to 100,000,000 lb. per year:

Senator W. A. Clark, United Verde mine, Jerome.

United Verde Extension Mining Co., Jerome.

Arizona Copper Co., Ltd. (Edinburgh), Clifton.

Miami Copper Co. (Lewisohn interests), near Globe.

Shattuck interests (Shattuck Arizona and Denn Arizona Copper Co.), Bisbee.

Smaller, but still important, are the yields of the following companies:

American Smelting & Refining Co. (Guggenheim interests), Tucson.

Shannon Copper Co., Clifton.

Consolidated Arizona Smelting Co., Humboldt.

Magma Copper Co. (Gunn-Thompson interests) Superior, west of Globe.

Iron Cap Copper Co., Globe.

Arizona Commercial Mining Co., Globe.

Arizona Hercules Copper Co., Ray, near Globe.

Besides these there are a very great number of other producers, ranging from several million pounds of copper per year down to occasional shipments, all of which help to swell the grand total.

Of all the companies operating in the Southwest, none is more intimately connected with it or has left a deeper imprint on it than the Phelps-Dodge Corporation, which rose from small beginnings to its present great position under the guidance of the late James Douglas, a man known far beyond the confines of the Southwest, and whose writings and personality have helped much to spread the fame of this territory.

The Phelps-Dodge Corporation — then Phelps, Dodge and Co.—entered the Southwest in the early eighties by acquiring the Copper Queen mine at Bisbee, soon after copper had been found here. Consolidating with adjoining mines and acquiring surrounding ground, the Copper Queen grew into one of the richest and most successful mines that the world has seen.

The company began to spread out early. Several mines at Mayer, near Humboldt (Bloggs and Hackberry), Yucca (Copper World), and Prescott (Copper Basin, Senator, and Snoozer) were acquired, worked for some time, and later closed down. The Copper Basin mine is the only one of these now producing steadily. Then followed the acquisition of the Detroit Copper Co., at Morenci, the United Globe Mines and control of the Old Dominion Mining & Smelting Co. at Globe, the Moctezuma at Nacozari, coal mines and coke works at Dawson, N.M. (Stag Canon Fuel Co.), iron and copper deposits near Oro Grande, N.M., the Burro Mountain Copper Co. in the same state, the Apache Camp copper mines, north of Tucson, and lastly the purchase of the Tombstone mines, now the Bunker Hill Mining Co. The company, after early smelting operations in Bisbee and Copper Basin, founded the town and smelting works at Douglas, and now has other smelters at Globe and Morenci.

Early in its history the principal owners started railroad construction, to facilitate the handling of the Bisbee ores. This has grown into the El Paso & South Western system, extending from Dawson, near the Colorado line in New Mexico, to Tucson, and constitutes with its branches a very important factor in transport in the Southwest. At one time the company came near acquiring control of the great Rock Island system, with whose line the railroad connects in New Mexico. For a while the company was supplying its own timber from lumber camps near Alamogordo, N.M. Hotels, mercantile business, real estate, newspapers, and other enterprises are conducted by the corporation and its allied branches. Of late years splendid educational and philanthropic institutions have been fostered, including working men's insurance and compensation, employees' pensions, and the profit-sharing bonus system. Walter Douglas, a son of the late James Douglas, is at the head of the concern as president.

The Calumet & Arizona Mining Co. (Cole-Ryan interests) also had its start in Bisbee. Mining men from Michigan and Montana, led by James and Thomas Hoatson and Charles Briggs, mine-captains of the north country, optioned ground adjoining the Copper Queen and started shaft-sinking. Down to 600 ft. and 700 ft. the search was fruitless, and the undertaking was on the verge of failure, when at last ore was struck and a second important producer was assured for the Bisbee district. The success here led to the formation of other companies on property farther out in the same field. Anaconda from Butte and steel people from Pittsburgh came in with strong financial backing. The new companies were all successful after anxious years and expenditure of millions of dollars in sinking deep shafts and draining heavy flows of water. Consolidation followed and the mother company, which had helped with money in times of need, is now being rewarded by continued existence when its original territory is practically exhausted.

The company has at all times been one of the most courageous and progressive in the Southwest. It has ever been ready to try, where others hesitated, provided a prospect tempted old experienced mining men, who were investing their own money as well as that of their associates. Not all of these ventures have been crowned with success, but this branching out has led to splendid returns. The company and allied interests now control the Cananea Consolidated Copper Co., Sonora, Mex., the Inspiration Consolidated Copper Co., near Globe, and the New Cornelia Copper Co. at Ajo. It is testing at present the Gadsden mine at Jerome and owns a number of other properties, not now producing, besides interests in South America.

The C. & A. smelter at Douglas is one of the great modern smelting plants in the Southwest, while the company installed not long ago a sulphuric acid plant for the leaching of oxidized ores at Ajo.

Cananea has its own smelter, while the Inspiration output is treated in the International smelter at Miami, also controlled by the same interests, which link the other companies.

The technical executive for these interests is with Dr. L. D. Ricketts, who has also recently been in actual charge of the operations, while the general manager, Col. John C. Greenway, was at the front in France. Dr. Ricketts is one of the few men who is of the Southwest, and whose accomplishments have raised him to an international position. Another man, who is perhaps the most far-seeing and keenest manager in the Southwest, but whose modesty has kept him from the public eye, is also connected with these interests, namely, Mr. C. E. Mills, now in charge of the Inspiration and Cananea companies.

Col. Daniel C. Jackling, one of the commanding figures in the copper industry of today, is universally acknowledged the man who first recognized the possibilities of the "porphyries." By technical ingenuity and perseverance, in spite of disappointments and discouragements, he has led them to success. His rise is the most spectacular in recent annals of mining, and is associated more with the Utah Copper Co., of Bingham Canyon, Utah, than with the mines of the Southwest. Of his widespread interests only the Chino Copper Co., of Santa Rita, N.M., and the Ray Consolidated Copper Co., of Ray, near Globe are within the Southwest proper. While these two companies are among the biggest in the territory, they are more or less only a part of a tremendous organization, centred in another part of the country, and have not exerted as deep an influence as other smaller companies, which are wholly of the Southwest.

I give approximate figures of production to show the size of these companies:

Phelps-Dodge Corporation (1916): Mined 2,300,000 tons, milled 1,500,000 tons; smelted 1,400,000 tons. Sales: 250,000,000 lb. of copper, 174,000,000 lb. of which were from the company's ore. To this must be added about

40,000,000 lb. copper from the Old Dominion, which is not a part of the corporation proper. By-products: 2,000,000 oz. silver, 30,000 oz. gold, and 10,000,000 lb. of lead. The present production, exclusive of O. D., is at the rate of 225,000,000 lb. per year. Coal production (1916) close to 1½ million tons, over 600,000 tons of which were coked.

Calumet & Arizona interests: C. & A. proper (1916) 75,000,000 lb. copper; Ajo (present rate) 50,000,000 lb.; Inspiration 100,000,000 lb. (present rate 11,000,000 lb. per month); Cananea (present rate 50,000,000 lb.). The present rate of production would give approximately 300,000,000 lb. per year.

D. C. Jackling interests: Ray Consolidated, mining and milling about 10,000 tons per day, production around 80,000,000 lb. per year. Chino, mining and milling capacity raised to 12,500 tons per day, which would bring production to over 100,000,000 lb. per year.

These three great organizations, including the Old Dominion with the Phelps-Dodge, are producing therefore at present at the rate of over 750,000,000 lb. of copper per year. To this must be added the by-products in gold and silver, which, while proportionately very small from the porphyries, amount to at least $10,000,000 from the other mines. Furthermore the steady lead production of the Copper Queen, the output of gold, silver, lead, and zinc at the Tombstone mines, besides manganese mined in recent years at Tombstone and by both the Copper Queen and C. & A., in Bisbee, are important contributors to metal output.

Areal Subdivision.—While the entire Southwest has seen prospecting and mining operations, the area is by no means uniform in importance. I believe Dr. F. L. Ransome was the first to divide Arizona into three regions, which trend diagonally across the state from N.W. to S.E. He designated them in their succession from north to south as:

1. The Plateau Region.
2. The Mountain Region.
3. The Desert Region.

These subdivisions have more than topographical importance. I shall extend their lines over the entire Southwest and use these subdivisions in discussing the ore deposits. Their boundaries are not sharp everywhere. The plateau character of the northern area disappears in New Mexico, where the great break of the Rio Grande valley has torn the homogeneity of the strata and warped them in startling folds and fault-blocks. The topographical character here is far more akin to the Mountain Region. The Mountain Region and the Desert Region blend into each other.

The Mountain Region is by far the most important of these three subdivisions, and perhaps 90% of the metal production of the Southwest is derived from it. This overwhelming importance is due as much to the greater intensity of mineralization as to the relatively greater exposed area of ore-bearing formations and less difficulties encountered in prospecting.

The Plateau Region. — The plateau region stretches from the north-west corner of Arizona to the New Mexico line at the latitude of about 34° N. Its mean elevation is over 7,000 ft. In Arizona its southern boundary is marked by the bold fault-escarpment of the Mogollon Rim. I extend this boundary in a straight imaginary line to the Mexican border. Thus this territory embraces nearly one-half of Arizona and the greater part of New Mexico. In area it is the largest, in mineral production the least important subdivision.

Within its borders is contained the unique mile-deep gash of the Grand Canyon of the Colorado, exposing past geological records from the Carboniferous down to the Pre-Cambrian age. Coal-measures are known in eastern Arizona and northern New Mexico, supporting a flourishing industry in the latter state, and extending over into Colorado. The greatest unbroken forest of the Southwest stands within its confines.

The Navajo Indian retains here his hunting and herding ground, where the white man still is a stranger. West of the Navajos are the remnants of the Hualpai and Mojave tribes, and east the Hopis or Moquis, while farther south the Pueblo Indians blend more freely with the Mexican settlers in Duque d'Albuquerque's domain and the white man's country.

Cattle and sheep raising and the lumber industry are paramount, and mining is dormant.

The formations are principally sedimentary and of nearly horizontal stratification, a great handicap to the prospector, intensified by spread-out flows of recent lavas and heavy coverings of detrital matter and forest.

In Arizona the sandstone and shale of the Coconino Beds, a member of the Carboniferous formation, are known to contain extensive copper deposits on both sides the Grand Canyon.

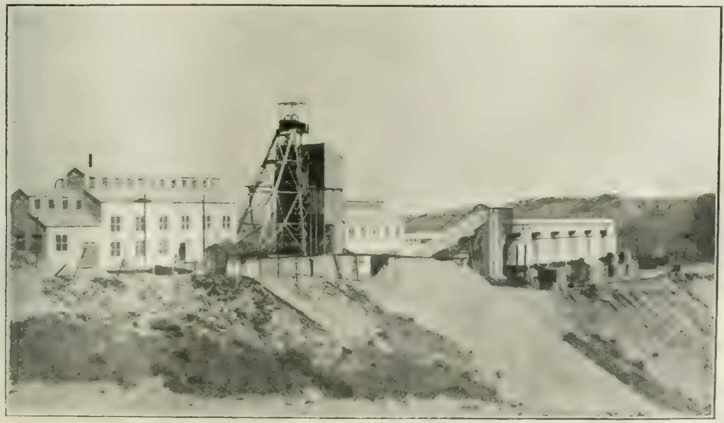
Ore has been hauled from the White Mesa a hundred miles across country to the railroad at Flagstaff. Car-load lots of over 50% copper ore have been shipped from the rim of the Grand Canyon farther west. Attempts at mining have also been made in that part of Arizona north of the Grand Canyon, which is tributary to Utah rather than to the rest of Arizona. But the obstacles of distance from railroad and undeveloped transport have proved too serious a handicap, and the field remains one of the prospective sources of copper.

The ore is found in sandstone beds, where copper minerals replace the aluminous cement of the sandstone. The average grade is low, but veins and irregular seams of high-grade ore penetrate the low-grade masses. The principal mineral is chrysocolla, with malachite and subordinate azurite. In the rich seams are found secondary chalcocite and impure oxides of copper. Hematite occurs in conjunction with the copper minerals.

Similar in character are the copper deposits in the Red Beds in New Mexico, which are found over a very large area and extend into Texas and Oklahoma, but have given rise to successful operations in very exceptional cases only. The Red Beds are Permian strata and contain horizons rich in fossil-plant remains. These are frequently transformed into coal. In mineralized sections the carbonaceous matter has acted as a precipitant for salts of copper. Chrysocolla, malachite, azurite, and copper pitch are most frequent; chalcocite is rather common, and even chalcopyrite and most rarely bornite are found.

Sandstone beds without fossil remains have absorbed copper by infiltration also, especially where some organic residue is indicated by apatite, but the fossiliferous horizons are apparently the only ones in which concentration of copper to high-grade ore was easily effected. This might have later migrated and been redeposited in fissures cutting across the strata.

In that part of New Mexico which I include in the plateau region, there are known also other types of copper deposits, besides the most universal Red Beds deposits. Such are: irregular veins and replacements in andesite, none of which has been prospected enough to prove consistency in depth; pyritic deposits in schist, for instance in the upper Pecos valley; and contact metamorphic deposits in the scattered islands of Paleozoic limestone. The most important of the latter is owned by the Santa Fé Gold & Copper Co. of San Pedro, New Mexico, a Lewisohn concern. The mine has been worked intermittently for a great number of years. The ore is found in a horizon near the base of the carboniferous limestone, which strikes north-south and dips 25° east. Mineralization follows east-west fissures of nearly vertical dip in narrow cylindrical bodies, but widens suddenly to very big shoots in shear zones, parallel to the strike of the limestone. Great masses of grossularite, andradite, epidote, actinolite, and quartz occur with the ore. The mine is equipped with a furnace producing a 35% matte from



THE MIAMI COMPANY'S HOIST, COARSE-CRUSHING HOUSE, AND FINE-ORE BINS.

ore varying from $3\frac{1}{2}$ to $7\frac{1}{2}$% copper according to economic conditions.

THE DESERT REGION.—I shall treat the south-western subdivision, the Desert Region, next. It is of greater actual importance than the Plateau Region, but cannot compare with the central or Mountain Region. The desert region ranges from and below sea-level to perhaps 2,500 ft. above. It is characterized by broad, level valleys. These are either baked adobe, the Mexican word for clay and air-dried brick, or bottomless sand, even with shifting sand dunes. In places the desert slopes appear also almost macadamized and carpeted with small pebbles, worn smooth by the sand-laden desert winds. Short, rugged mountain-ranges, grating under foot and cleft by steep canyons, rise bare and forbidding from the desolate flats. From water hole to water hole is many a dreary mile. Living springs are so few and seem unnatural where found. Tanks and pot-holes, in which rain water survives under covering sand, are the salvation of the prospector. They swarm with insects in summer-time, where the heat does not exceed the vitality of everything except man, coyote, and rattlesnake. Even the hardy desert tribes, the Pimas and Papagos, cluster only around the least forbidding borders of this section. Their wells used to be easily traceable; greenish, decaying raw-hide buckets spread an inviting stench far over the country. This helpful guide though will soon be a thing of the past, as the Government is drilling deep wells and substituting gasoline pumps for wheel or windlass.

While the desert does not present an attractive picture or inviting abode, it has an indescribable charm as well in its bleak grandeur, as especially in the short, ethereal spring, when heavy night-dew moistens its surface and delicate, many-coloured flowers spring up over night to wither and die under a pitiless sun.

In California, the major part of San Bernardino, Riverside, and Imperial counties belongs to this subdivision, together with nearly one-third of Arizona and the north-western part of Sonora.

More disappointment than success has here been the outcome of copper mining in the past, but the territory has not been developed to capacity, and there are excellent possibilities for future discoveries. Copper is found principally in schist, very old limestone beds, and in Tertiary andesite-flows and intrusions.

The most important mine of the whole area, the New Cornelia at Ajo, Pima county, Arizona, does not come under any of the above headings. The mine, a subsidiary of the C. & A., of Bisbee, has been exhaustively described in connection with the adoption of leaching methods. A very recent monzonite, penetrating Tertiary rhyolite, contains disseminated pyrite-chalcopyrite ore with accessory bornite. Oxidation has affected a large part of this deposit, but secondary chalcocite enrichment is lacking except in very limited sections, where the ore-body shows abnormal dip and depth. A total of over 50 million tons of ore has been proved by drilling and underground development. This tonnage will probably be increased by further work. About one-fourth of it is oxidized. The computed average is between 1·5 and 1·6% copper, and the sulphide ore carries from 30 to 50 cents in gold and silver. The greater part of the ore is mineable by steam shovel. This method of mining is not only cheaper in actual cost, but also prevents, by stripping the barren overburden from above the ore, a dilution of the ore with incoming waste-material, a very important factor in these low-grade deposits. The oxidized ore is being leached with sulphuric acid, which is manufactured at the C. & A. smelter at Douglas. For the sulphide ore concentration by flotation is contemplated. The output is at the rate of 50 million pounds of copper per year.

In Yuma county, Arizona, south of the Bill Williams river, is the small town of Swansea with the mine and smelting works of the Clara Consolidated Copper Co. This company was partly financed by European capital. It came to grief several years ago. The smelter is idle, but the mine is being operated by the Clark interests (United Verde). The ore is an especially attractive fluxing ore, consisting of hematite with pyrite and chalcopyrite. It occurs in large lenticular bodies in limestone and schist country, and is probably the replacement of an andesite dyke. The mine was producing up to 250 tons of $3\frac{1}{2}$% ore per day some time ago.

A few miles to the west is the Planet mine, formerly operated by the Lewisohn interests. This mine has perhaps the most wonderful outcrops of any copper mine in the Southwest, regular mountains of iron oxide stained green with copper. Quite a large amount of oxidized ore has been mined, but the search for sulphide ores has not been successful.

In this same vicinity and on toward the Colorado River are a number of highly interesting and promising prospects, but development work has lagged. To the south-east this copper belt extends into the Harcuvar Mountains, where a number of small mines are in periodical operation, and very similar geological conditions exist again north of the Bill Williams river in Mojave county, where the Cactus Queen mine gives promise to develop into another big mine of Swansea type.

In Riverside county, California, south of Vidal, are interesting cork-screw pipes of copper-gold ore in limestone, which have been followed down for 600 ft. and 800 ft. in spite of an average diameter of only from 10 to 15 ft. Nearby are very attractive copper veins in andesite.

North of Vidal in San Bernardino county is found widespread copper mineralization in schist, and farther east strong but probably superficial copper-silver veins in andesite. The Ord mountains near Daggett, California, show wonderful copper and iron stained quartz croppings in schist with only enough work done to discourage the average mining man. Around Needles and Ivanpah copper and copper-gold veins are worked in a quiet way. They flare up every once in a while in headlines in the daily press, when a shortlived strike of exceptionally high-grade ore stirs the dreary lethargy of the desert.

Along the fringe between the desert and mountain regions in Arizona are the gold district of Oatman and the lead-zinc district of Kingman-Chloride in Mojave county. The latter contains at Mineral Park good indications for copper, probably in genetic relation with the turquoise deposits in monzonite in the same locality.

Farther south are copper-zinc veins and copper-molybdenite veins in the schist in the Hualpai Mountains. East from here, in the Cottonwood Cliffs range, the Clark interests are operating the small Copper Giant mine on a pegmatitic quartz vein with copper sulphides in schist country-rock.

North of the Santa Maria river in Yavapai county, in one of the most inaccessible sections of Arizona, the Lewisohn interests retain a hold on the Bagdad Copper Co. Here has been established by drilling and underground work a large disseminated copper deposit in granite. The proved tonnage is variously stated as from 13 to 21 million tons and the grade as from 1.5 to 1.7% copper. Part of the ore is oxidized. The mine is idle.

South of Casa Grande, in the Quijotoa mountains, Pima county, the Brownell mine shows good but irregular copper-silver ore in schist; nearby the Copperosity and Reward mines contain irregular pipes of copper ore in limestone. East from here is the Lakeshore mine, owned by Frank M. Leonard of Butte, Montana. This mine has large reserves of rather low grade oxidized copper ore with good sulphide ore coming in. The ore is found in an altered andesite dyke in limestone. The distance from railroad, over 30 miles, has been a bad handicap up to now. Strong contact metamorphic zones in limestone with occasional outcrops of copper ore are found nearby. South and south-east from here in the Sierra Prieta and Comobabi mountains occasional shipments of high-grade chalcocite and silver ore are made from narrow veins in andesite.

The most important mine in this section is the Silverbell mine, formerly the Imperial Copper Co., now owned by the American Smelting & Refining Co. (Guggenheim interests). This mine produces about 10,000 tons of 3% ore from a contact metamorphic deposit in limestone. Julius Kruttschnitte Jr. is manager of the mining operations of the A. S. & R. in this section, and under his administration the company is branching out steadily and is gradually becoming an important factor, in spite of the fact that this company is the last of the great corporations to enter the Southwest and has been taking what other people overlooked or disdained. The same company operates the Sasco smelter near Silverbell of about 1,000 tons daily capacity, the greater part of this tonnage being custom ore.

This enumeration exhausts fairly well the copper industry and copper prospects of the desert region and its borderland. The only mines of important present production are the New Cornelia, the Silverbell, and the Swansea mines. The balance await the advance of transport, improvement in metallurgical methods, or the investors' capital for further testing or equipment. The sum total is not an overbright picture, and neither the Plateau Region nor the Desert Region has been instrumental in making the Southwest the greatest copper land of the world or to secure for Arizona the proud name "Copper State." This is solely due to the remaining third, and in area smallest subdivision, the Mountain Region.

(To be continued).

The Derivation of some names associated with mining is unusual. For instance, Coniagas, a mine at Cobalt, takes its name from the chemical symbols of the four metals it produces, Co, Ni, Ag, As. Cuyuna, a range of hills in Minnesota noted for its iron and manganese deposits, was called after "Cuy," otherwise Cuyler Adams, an early pioneer, and "Una" his dog.

FROTH FLOTATION

By V. F. STANLEY LOW,

Member of the Institution of Mining and Metallurgy, Member of the Australasian Institute of Mining Engineers, Member of the American Institute of Mining Engineers

The author, an Australian engineer, was connected with Broken Hill for a number of years, being manager of Block 10 mine from 1902 to 1910.

(Concluded from the April issue, page 216)

PREFERENTIAL FLOTATION.—In the early days of water-concentration, long before the introduction of blende flotation, it had been observed that wherever the mixed pulp splashed or cascaded on its way through the milling process a froth or foam was formed which floated on the surface of jigs, settlers, etc. Assays taken of this froth showed it to consist mostly of a highly argentiferous galena. In some of the mills this was for a time skimmed off and sent to the bins with the ordinary galena concentrate. In fact, the Sulphide Corporation in 1901 put up an experimental plant to ascertain whether galena concentrate could not be profitably produced in this manner. In this plant a series of inverted cones was arranged so that material passing through the bottom of one would enter the top of the next cone below. Into the lower part of each cone water and compressed air were conducted through their respective pipes. The froth flowing off from each cone was collected; but as the froth produced in this experimental plant did not assay more than 30% lead the work was not continued.

In later days it would appear that several experimentalists—Owen, Lyster, Seale, Shellshear, Waterhouse, and others—got on the track of preferential flotation about the same time.

Lyster treated the slime pulp by passing it cold through a 3 in. centrifugal pump, the intake of which was reduced to 1 in. in proximity to the pump (Fig. 1). At the point of reduction a vertical pipe $\frac{3}{8}$ in. in diameter, surmounted by a funnel, was tapped into the intake pipe; air was drawn in through the $\frac{3}{8}$ in. pipe, and eucalyptus or other reagent was fed into the funnel. The pulp was delivered by the pump to a separator of special shape where the lead froth overflowed, and the residue was drawn through the bottom by a second centrifugal pump and delivered to a second separator with more air but without additional reagent, and so on. The concentrate overflowed at the top of each vessel.

The Owen machine (Fig. 2) consisted of a cylindrical box with a porous bottom through which passed a vertical spindle carrying an impeller. The impeller was placed close to the bottom of the cylinder, and above it was placed a circular plate, surmounted by a baffle. The plate was intended to prevent the solids from dropping directly on to the impeller. A sample of Block 10 ore submitted to this machine in its earlier days, gave, after aeration in a 0·11% acid circuit, a galena concentrate carrying 51% lead, 41 oz. silver, and 10% zinc. Oil and acid were next added and a blende concentrate assaying 45% zinc resulted. Both the Lyster and Owen processes obtained the galena concentrate by agitation and aeration in the cold solution. The blende was subsequently obtained by adding reagents and warming the solution.

In the Seale-Shellshear cascade process (Fig. 3) no mechanical agitation is employed, all the aeration taking place as the pulp descends from

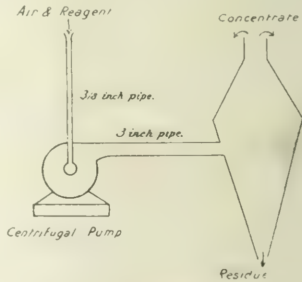


FIG. 1. DIAGRAM OF LYSTER MACHINE.

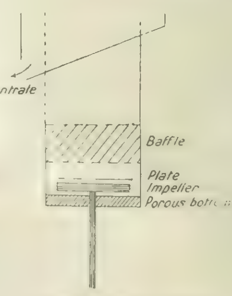


FIG. 2. DIAGRAM OF OWEN MACHINE.

one vessel to the next in the series. A Seale-Shellshear plant was running at the Junction North mine, Broken Hill, at the end of 1914. Each unit consisted of two sections of six pots each; each pot was cylindrical in form, 16 in. in diameter and about 24 in. deep. From the bottom of each pot a 5 in. bend fitted with a 3 in. spigot led the pulp to a 12 by 12 in. square aerator placed over the head of the next cylindrical pot in the series. The pulp in swirling in the box became aerated and also carried air with it as it fell to the next pot. Each pot was fitted with an overflow launder; and beneath the bottom of each pipe was placed a plate for the purpose of breaking up the pulp as it was delivered to the pot. Special arrangements were made in the top pot to ensure an even flow to the pots below, each of which was reduced in depth proportionately to its position in the series so as to allow for loss in volume of pulp, part of which overflowed each box in the form of froth. The value of the froth overflowing from the last five pots remained fairly regular; but that from the top, or equalizing, pot showed some little variation.

Galena froths are generally found to be less stable than those of blende, and it is therefore advisable to float these off as quickly and as smoothly as possible.

The pulp leaving the sixth and lowest pot of the series is delivered to an elevator where reagents are added and is lifted to the top pot of the next series where the pulp passes through six pots as before; but in this case a blende, in place of a galena, float is obtained.

In 1914, after carrying out a considerable amount of investigation, the Sulphide Corporation remodelled the plant which had previously been in use for the treatment of dump slime, so as to make it suitable for preferential flotation. Reference has already been made to this plant, which had now remained idle for some four years. Here the pulp was delivered to a set of six mixer-boxes of the sub-aeration type, 3½ by 3½ ft. by 5 ft. deep with 18 in. impellers at 2,300 ft. peripheral speed per minute. A galena concentrate was obtained from the first four boxes, the float from the last two boxes being returned to the head of the mixer. The unfloated material was next heated to 130°F., acid and eucalyptus were added, and the blende floated in another Minerals Separation machine; the concentrate from the latter machine was passed over vanners. These operations were carried out on dump slime and gave a galena concentrate containing 50% lead and a blende float concentrate carrying 42% zinc.

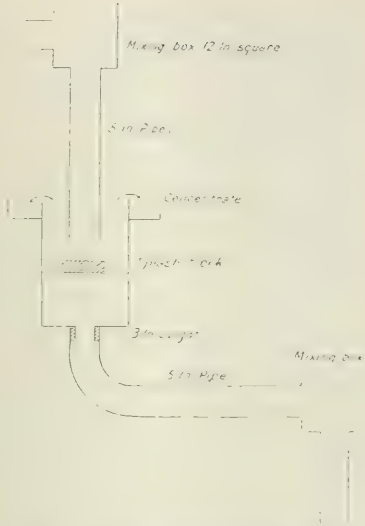


FIG. 3. DIAGRAM OF SEALE-SHELLSHEAR MACHINE

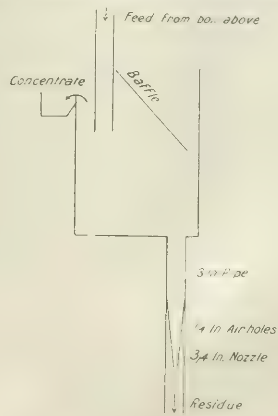


FIG. 4. CASCADE MACHINE

The next step was the treatment of current slime produced in the lead mill. This was done in an eight-box machine of the sub-aeration type, 2 by 2 by 3 ft. deep with 10 in. impellers at 1,000 r.p.m. This proved satisfactory, and 16 more boxes were installed. These boxes gave a galena concentrate of 67% lead from a 13·3% lead feed.

For the preferential flotation of the coarser galena a modification of the Seale-Shellshear system was inaugurated (Fig. 4). Rectangular boxes took the place of cylindrical pots, and air was sucked in through the agency of nozzles placed in the perforated down pipes. There were six down pipes 3 in. in diameter from each box to the next below; and in each pipe a nozzle contracted the flow to $\frac{3}{4}$ in. diameter. Surrounding the nozzle, holes $\frac{1}{4}$ in. in diameter were bored in the 3 in. pipe. Each of the nine boxes in the series was 36 by 18 in. by 28 in. deep, and was placed, top to top, 4 ft. 9 in. above the next box below. The two cascade units now in use in the main milling plant of the Sulphide Corporation have put out of commission 24 tables and 30 vanners.

In 1916 the Broken Hill Proprietary company put up a 500 ton per day plant for treating slime by the Leslie Bradford SO_2 process (Fig. 5). In this process about 10 lb. of nitre cake is added as an emulsifier to each ton of slime as it is delivered from the dumps. The slime is then sent to a mixer 8 ft. in diameter and 6 ft. deep, where it is stirred at 42 r.p.m. with the necessary quantity of solution to bring it to a flowing condition. From the mixer the pulp is delivered to a slowly revolving tube-mill where such lumps of slime as may have passed through the mixer are disintegrated. A pump then delivers the material to the main storage tank 30 ft. in diameter and 5 ft. deep. In this tank arms 26 ft. in diameter move at 3 r.p.m., and are so constructed as to send the solids into the circumference of the tank. From the storage tank the pulp is sent to a small mixer 5 by 5 by 5 ft. with arms 4 ft. 6 in. in diameter moving at 29 r.p.m. Here sufficient solution is added to bring the pulp to 25% solids by weight. Enough sulphuric acid is now added

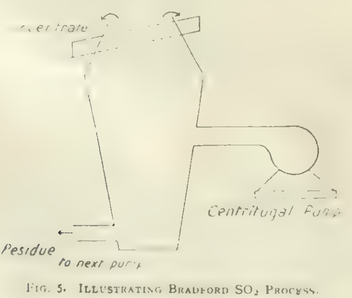


Fig. 5. Illustrating Bradford SO_2 Process.

to make the pulp acid, together with about 2 lb. of sodium hyposulphite. The hyposulphite is added in the form of a 30% solution. The pulp now goes to a further mixer, where the SO_2 liberated from the mixture of chemicals becomes active. In this last and final mixer the acidity is brought to about 0·03%, the temperature to about 90°F., and the density kept, as stated before, at 25% solids by weight. The 4 in. delivery from this mixer goes to an agitator in the form of a centrifugal pump equipped with a special runner, $17\frac{3}{4}$ in. in diameter. The runner is in reality a disc, from each side of which project for $1\frac{1}{2}$ in. two circles of pegs which revolve concentrically between two rows of similar pegs on the inside of the pump at 1,000 r.p.m. Two pipes $\frac{1}{2}$ in. in diameter connect the intake of the pump, which is of the Y form, with the sulphur burners, and through these pipes SO_2 gas and air are drawn into the pulp. The rate of flow through the centrifugal agitator regulates the amount of air and SO_2 drawn in; and the flow is, in turn, regulated by sliding doors in the mixers, etc. From the centrifugal mixer the pulp is delivered to a flotation box where the deep galena froth which forms overflows to a thickener, thence to concentrate vats where it is brought up to 70% solids, and finally to filters where the moisture is reduced to 10%. The pulp from the bottom of the flotation box is delivered to the next similar centrifugal agitator in the series, thence to a second flotation box, and so on until this has been repeated nine times. Most of the galena is obtained from the first four boxes in the series. Enough sulphuric acid to keep the solution acid is added to the sixth box, and the float from the ninth box is returned to the head of the system. Care is taken to keep the temperature of the flotation boxes at 90°F. The pulp leaving the bottom of the ninth flotation box goes to a thickener where the pulp is thickened to 60% solids by weight. From the thickener the pulp is delivered to storage tanks, with the usual revolving arms, situated at the head of the blende section. The clarified liquor from the thickener just mentioned is returned to the head of the lead section. In the storage tank of the blende section the temperature of the pulp is brought up to 120°F., and the pulp is then sent to a 5 by 5 ft. mixer at 30 r.p.m., where sufficient circulating solution from the blende section is added to bring the pulp down from 60% to 20% solids. Sulphuric acid is here added so as to bring the acidity up to 0·3%. From the mixer the pulp is delivered by a 4 in. pipe to a centrifugal pump which acts as an agitator, where air only is drawn in through the ½ in. pipe, the amount of air being regulated by a valve. In the blende section there are six flotation boxes similar to those in the galena section. The overflow from the flotation boxes goes to a re-treatment plant where the material is refloated in three flotation boxes. The float from these goes to the blende storage department. The tailing leaving the sixth flotation box in the blende series is thickened, the liquor returned to the section, and the solids go to the waste dump.

A pulp assaying 12·8% lead and 16·5% zinc may be separated by this process into a blende concentrate assaying 50% zinc and a galena concentrate assaying 63% lead.

There are several matters in connection with this process which require careful attention. With Broken Hill Proprietary material the presence of more than 3 lb. of hypo. per ton makes the blende slow in rising in the blende section and consequently gives a high tail. If the temperature of the pulp at the head of the galena section is raised above 90°F. it is probable that the blende, as well as the galena, will float; a similar result is obtained if too much acidity, which should be about 0·03%, is allowed in this section. On the other hand, if the solution becomes neutral the grade of the galena concentrate is lowered. If the pulp in the galena section has more than 27% solids the result will be a galena concentrate lower in lead, a lower recovery, and a blende concentrate lower in zinc.

LLOYD COPPER.—When the writer returned to Australia in January, 1914, to reorganize the work at the Lloyd copper mines, he found that tube-mills and a Minerals Separation flotation section had recently been added to the concentration plant, but that the mill was limiting the mine output. Various alterations were taken in hand, and before very long the mill had outstripped the mine output. As it was not possible to obtain sufficient underground labour to bring the mine output up to the capacity of the reorganized mill, attention was turned to the dumps of tailing produced from previous milling operations, This tailing had been carefully sampled and the samples thoroughly tested in the flotation laboratory, where it was found that, owing to oxidation, only a poor recovery could be expected. However, it was decided to run some dump tailing into the plant and feed it to the tube-mills, where it would enter into circuit with the crushed crude ore. Although many tons of dump tailing were put into circulation in the mill, satisfactory assay-values of concentrate and tail were obtained from the flotation unit. It was then decided to try a run on the dump tail alone, in order to find out the actual recovery from the tail. At first the float was excellent, but at the end of the first hour a gradual lessening of the froth became noticeable; and the froth continued to get less and less until at the end of three hours it was evident that the tailing alone could not be successfully treated. As soon as the crude ore got into circulation again excellent results were again obtained; and subsequent work plainly showed that the tailing was amenable to flotation so long as crude ore was in circulation, but that any attempt to treat the dump tail by itself was followed by unsatisfactory results very similar to those obtained in the laboratory.

The following results were obtained from treating two lots of dump tailing in the mill without the assistance of crude ore in the circuit: (*1*) 55 tons of dump tail assaying 1·7% copper gave 2·06 tons of concentrate assaying 17·8% copper; the flotation tail assayed 0·75% copper and the recovery was 38·3%. (*2*) 94 tons of dump tail assaying 1·5% copper gave 3·09 tons of concentrate assaying 14·2% copper; the flotation tail assayed 0·85% copper and the recovery was 31·16%. With the crude ore and dump tail both under treatment at the same time it was estimated that the recovery on the dump tailing rose to 58·8%. The total recovery from both materials was 79·1%. The mill at this time was making an average recovery from the crude ore alone of 92%, of which 35·8% was recovered from the jigs and 56·1% from the flotation unit.

A somewhat analogous state of affairs exists at the Inspiration mine, Arizona, where part of the ore is found in schists and part in altered granite. The schistose ore is very amenable to treatment; but not so the granite. In practice it has been found that if the latter is mixed with the former in any proportion up to 20% a satisfactory float and a good recovery may be made.

At the Lloyd copper mine it had been the custom, prior to the introduction of flotation, to roast the mill concentrates in Edwards furnaces before sending them to reverberatory furnaces, and satisfactory results had always been obtained. But with the advent of the fine grinding necessary for flotation treatment considerable losses were incurred in roasting and subsequent handling; and when the charges containing the calcined fine concentrate were dropped into the reverberatories clouds of dust could be seen issuing from the chimney stacks. This resulted in such loss of recovery that the roasting of the flotation concentrate was abandoned and the material was eventually fed by hand in its moist condition through the side doors of the reverberatories. Fortunately the reverberatories had plenty of spare capacity, and it was therefore possible to periodically use one of the furnaces as a roaster to deal with any surplus concentrate on hand. This was done by charging the furnace entirely with green concentrate, leaving all doors open and working with a low furnace temperature. When the sulphur had been sufficiently removed the doors were closed, fires were brought up to the normal, and smelting continued on ordinary lines. At the Wallaroo & Moonta mines, South Australia, where the concentrates from the water-concentration plant were roasted in McMurtie pots before going to the blast-furnace, the introduction of flotation caused somewhat similar trouble. Great difficulty was found in obtaining a satisfactory sinter from the pots with the fine flotation concentrate; but the trouble was overcome by feeding a certain proportion of green concentrate on the top of each charge to the blast-furnace. The concentrate in this way entering a cool section of the furnace shaft gradually had its temperature raised as the charge descended, and by the time it had reached the full force of the tuyere blast had become completely sintered.

REMOVAL OF MOISTURE.—The removal of moisture from flotation concentrate is, of course, a matter of much importance where freights are high or smelters' objections have to be met. Various methods have been tried, such as draining in porous-bottomed vats, steam drying, air drying, filtering, etc. The usual preliminary to all these methods is the thickening of the concentrate in a Dorr machine or similar appliance. For steam drying it is usual to send the thickened material to shallow tanks of considerable area, on the bottoms of which are nests of steam pipes. This process is slow and costly, but the moisture can be brought lower by this than most of the other methods. Using steam at 50 lb. pressure it would probably take at least 24 hours to bring a 12 in. layer of copper concentrate from 40% to 10% moisture and would probably require $\frac{1}{4}$ ton of coal to dry one ton of concentrate. At the present time filters of the revolving drum type appear to be most in favour, for although they are more costly to install and do not reduce the moisture to the same degree as can be done in a steam dryer, the costs of operation are lower and the output is greater. In Missouri it is stated that a 12 ft. by 11 ft. 6 in. Oliver filter will put through in 24 hours 50 tons of concentrate carrying 35 to 40% moisture, giving a cake $\frac{1}{8}$ in. thick containing 15% moisture. Experience has also shown that by heating the filter feed to 130°F. the capacity of the filter is increased by about 20% and that the final amount of moisture is reduced by some 2%. At Inspiration a 12 by 12 ft. Oliver filter puts through 120 tons of concentrate and reduces the moisture to 17%. The injection of steam into the filter or the use of slacked lime, while not lessening the amount of moisture in the cake, increases the filter capacity.

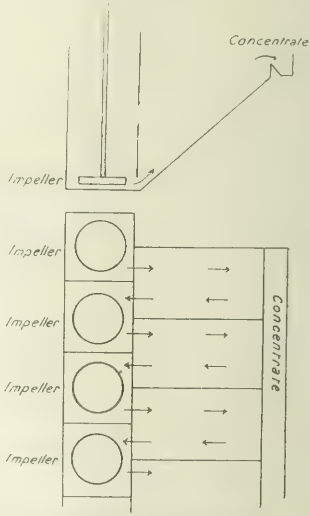


FIG. 6. THE STAGGERED TYPE OF PLANT

DESIGN OF PLANT.—Since the days of the granulation plant at the Sulphide Corporation's Central mine many changes have been made in the form of machine used in connection with the Minerals Separation process. The simplest of these machines is probably the staggered type (Fig. 6) in which the separating boxes are staggered with the agitating compartments so that the material leaving the first agitating compartment flows to the first separating box and thence to the second agitating compartment, and so on, the bottoms of all agitating compartments and of all separating boxes being on the same level. Another form of machine, in which the bottoms of the agitating compartments are at a somewhat higher level than those of the separating boxes, is open to the objection that the material from the first separating box must be sucked through a pipe into the second agitating box by the action of the second impeller, and so on, and that in the event of a sudden stoppage these pipes are liable to clog.

In the Hebbard machine used in preferential flotation the impellers are under-driven, and air is brought in below them by a ½ in. pipe. As the compartments between the impellers extend to only 18 in. above the bottom, the five impellers may be said to be acting in one continuous trough.

In the Callow system aeration is obtained by means of a porous bottom. The material is first agitated with the necessary reagents in a form of Pachuca tank and then goes to the first, or rougher, cell in which aeration is produced by passing compressed air through the porous bottom. The tail from this machine goes to waste and the float goes to the second, or cleaner, cell, which is 9 ft. long by 2 ft. wide, with parallel vertical sides and a bottom sloping at 3 or 4 inches to the foot. The froth overflows right along both sides and the residue leaves by a spigot placed at the lower end. The chamber below the porous bottom is divided into eight compartments to which air is supplied at about 4 lb. pressure, about 10 lb. of free air per minute being required per square foot of porous bottom. The tail from the cleaner is returned to the original feed; the overflow goes to the concentrate bin.

Before deciding on the form of machine to be used in their new flotation plant the Anaconda company made exhaustive comparative trials between the Callow machine and the Minerals Separation machine. As a result of these tests it was decided to install four of the latter machines, each having 15 agitating compartments 3 by 3 ft. and 14 separating boxes of the standard M.S. design. The impellers were top-driven by bevel gear at 275 r.p.m. and were 18 in. in diameter. Each machine produced a concentrate, a middling which was returned to the machine, and a tail which went to waste. Each of these machines was capable of treating 400 tons of sand or 175 tons of slime per day, and from a 2·1% copper feed produced a 12% copper concentrate and a 0·27% copper tail.

In the Groch machine the impellers are in the form of centrifugal pump runners mounted on hollow shafts (Fig. 7). These impellers work in a submerged rectangular trough placed within the main flotation compartment. Each runner is divided horizontally by a diaphragm, so that the upper part of the runner draws in air and reagent from above, and the lower part of the runner lifts up pulp from below from the flotation compartment. The air, reagent, and pulp are all intimately mixed by being thrown out centrifugally against the sides of the inner trough, the whole is forced up over these sides, the froth rises to the surface and overflows along the two sides of the outer box, and the tail eventually leaves the machine through a spigot in the end.

Ruth also uses an impeller of somewhat similar design in his machine, except that the air entering through the hollow shaft from above is discharged into the pulp through four hooded ports on the upper side. The pulp is drawn up from below in a similar manner to

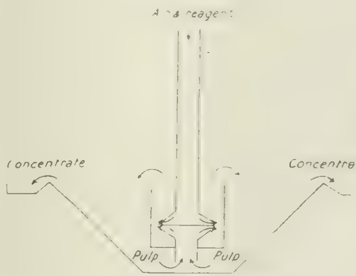


FIG. 7. THE GROCH METHOD.

the Groch machine. With this type of impeller it is claimed that the bubbles and mineral particles are thrown upward together at the same velocity so that no counter-currents are formed, and the bubbles and mineral particles have an ideal opportunity for intermixture.

Pearce, in treating custom ores, had great difficulty in dealing with such as were heavily charged with amorphous or colloidal material. In using the ordinary Minerals Separation machine he found that the colloids remained in the machine and thus accumulated, so that the proportion of amorphous material became unduly heavy. His froth was formed well enough but carried no mineral. He closed the partition holes to prevent back flow and raised the openings between the agitating and separating boxes so as to get better circulation of slime. He subsequently designed a machine in which he states he causes the colloids to flow forward and the coarse material to remain behind until an equilibrium is reached where the overflow is practically the same as the feed and yet the proportion of colloids in the machine is much less than in the original feed.

The K & K is a machine of an entirely different kind. It consists of an outside cylindrical envelope 10 ft. long and 30 in. in diameter, with a V-shaped separating box placed at one end, over the lip of which the concentrate flows; inside this envelope a revolving drum is mounted on a longitudinal shaft, and this drum is fitted with riffles and has openings through its circumference. The drum revolves at about 200 r.p.m., and has a clearance of $\frac{5}{8}$ in. between it and the envelope. Two air ducts at the ends admit air for aeration.

The Janney machine is mostly notable on account of the individual motor drive to each impeller; and a large plant equipped with this class of machine has the appearance of a large apiary. This would appear to be the ultra-refinement of individual drive to which, it is to be hoped, no metallurgist would commit himself without first having made exhaustive research as to its utility. But the number of variations in the machines increases as the Minerals Separation process comes farther into use and local variations in the nature of the ores have to be overcome.

REAGENTS.—The variation in the nature of the ores has been responsible, to a great extent, for the introduction of many different reagents: sulphuric acid, SO_2 gas, sodium hyposulphite, camphor, eucalyptus, amyl alcohol, gas-tar derivatives, sludge acid kerosene, pine oil, resin oil, sodium sulphide, sodium polysulphide, etc. These are used either alone or in combination; and, so far as has been yet discovered, there is nothing to indicate which reagent or combination of reagents will prove most satisfactory with any particular ore. This must be found by experiment, and the experimentalist must be prepared to meet with many contradictions which, up to the present, have remained unexplained. For instance, sulphuric acid is used with advantage at Anaconda, while at the Old Dominion mine, which has an ore closely approximating that of Anaconda in chemical analysis, sulphuric acid is found to be deleterious. On the contrary, caustic soda is added; but this is mainly for the purpose of flattening down the froth and allowing of the use of a much smaller amount of launder water.

THEORIES OF FLOTATION.—The theories as to the reason for flotation have been numerous and varied, but have had, so far, more of an academic than of a practical value. The rough and ready explanation sometimes offered is that if finely-crushed ore is agitated in a vessel of water containing an admixture of certain reagents "some particles get wet and some don't; the dry ones float and the wet ones sink." Following up this idea one suspects that particles of sulphide have an aversion to wetting much greater than particles of gangue; and that some sulphides have a greater aversion to wetting than others. Moreover, the aversion to wetting possessed by sulphides does not, so far, appear to be possessed by carbonates; and, although attempts have been made to coat the carbonate particles with a sulphide film by the use of a polysulphide solution and float them, it would appear that satisfactory floats on a commercial scale have not been achieved and that the extraction of the metallic contents of low-grade carbonates is more likely to be gained by leaching than by flotation. The allusion to wetting reminds one that very little has been done with regard to framing laws for this phenomenon. We know that utmost wetting is absorption and that the angle of incidence showing the aversion to wetting can be measured; but there is still a great deal to be learned in this branch of science. Then, also, explanation is required as to the function of oil in the process. It may be that a portion of the oil goes actually into solution in the water and therefore alters the nature of the whole of it; but it seems inconceivable that, say, a pound of oil beaten up with a ton of solids and three or four tons of water can be so disseminated that each particle of mineral which floats has been acted upon by a particle of the oil in emulsion. If plain water is agitated by an impeller the water immediately becomes charged with large bubbles which rise straight up and escape at the surface. With the addition of oil and further agitation the water becomes milky white, presumably owing to the presence of myriads of minute bubbles. If, then, the flotation function of oil is to imprison minute bubbles in water, then also any other liquid than oil which can produce an equal amount of bubble imprisonment will be equally as effective as oil.

COSTS IN FLOTATION.—Very little can be said with regard to the cost of plant construction and concentrate production, as these depend upon the variable factors of rate of wages, cost of materials, etc. The writer has before him the estimated cost of construction of a Minerals Separation plant capable of treating 2,000 tons of material, including 400 tons of slime, per week. These figures are given in the table on the next page.

	£
Building	450
Agitation and Flotation Machine	300
Shafting, &c.	100
3 Elevators	210
Draining Belt for Concentrate	304
Water Supply	50
Pump and Sump	60
Electric Light and Wiring	60
Motor and Pump	150
Motor for Agitators	120
4 Settlers for Feed	1,280
18 in. Conveyor	200
Clarifying and Water Storage Tanks	700
Acid Supply and Transport Tanks	500
Concentrate Bin	1,800
Belts for Tail Disposal	904
Belt for Concentrate Disposal	240
Feed Storage Bin and Elevator	570
Tube-mill	800
Motors for Conveyors	350
Supervision	200
Boiler	400
Total	9,748

The actual running costs for a plant about twice the size of the above were divided up as follows:

	Shillings
Superintendence	0·118
Labour	1·632
Stores	0·353
Acid	1·182
Reagent	0·754
Water	0 230
Fuel	0·355
Power	0·545
Assay Office	0·165
Lighting	0·046
Workshops	0·170
Total	5·541

These costs make no allowance for crushing or for the payment of royalty.

TESTS.—In carrying out laboratory work very fair results may be obtained by manual agitation in a 20 c.c. glass measure with parallel sides and footstep which enables the measure to stand of itself when not in active use. In using such a glass the ingredients are introduced and the glass grasped toward the lower end in the right hand; the open end is closed by placing the palm of the left hand over it. If the operator then assumes a semi-stooping position and rapidly shakes the measure up and down, and on each down stroke allows his right forearm to strike his right knee, he should get a fair agitation. When the glass measure is brought to rest, the float comes to the top and may then be removed with a spoon.

When power is available a good plan is to have a small motor fixed to the wall with its spindle in a vertical position. Under this motor is placed a stand on a vertical sliding base which will allow of the stand being raised, lowered, or fixed at will. A rod to one end of which an impeller is fixed is so constructed that it can be bolted at the other end to the spindle of the motor, thus bringing the impeller immediately over the sliding stand. On this stand is clamped a gun-metal vessel with two plate-glass sides through which operations may be observed. A convenient size for such a vessel would be 5 in. square inside and 8 in. deep. There should be an outlet $\frac{1}{2}$ in. diameter or more in the bottom. The glass may be made water-tight by wedging it against a rubber washer which abuts against the flanged side of a gun-metal casting. The method of using this is as follows: Fill the vessel to within $2\frac{1}{2}$ in. of the top with water at 120 to 160°F., the vessel being clamped on to the stand below the motor, raise the stand and vessel until the impeller almost reaches the bottom of the vessel, clamp the stand in position, start the impeller, and when it is at full speed pour in a convenient weight of ore which has been crushed to pass through a 60 mesh sieve. From time to time pour in from a graduated tube small quantities of dilute sulphuric acid of known strength, testing afterward with methyl orange. When the liquor becomes acid add from a burette, say, 0·2 c.c. of a frothing reagent such as eucalyptus, and continue agitation for two or more minutes. Stop the motor and inspect the float. If the float is not good it may be that the acidity of the solution has been lost during agitation or that more reagent is required. Trials should go on until a good float is obtained. When such has been obtained the froth is to be taken off with a spoon and further agitation given, and so on until no further float is obtainable. After having removed the froth, empty the the box through the bottom vent and collect the residue. Collect the float and residue, then dry, weigh, and assay them; or the weight of the residue may be estimated by difference. A convenient weight of material is 448 grammes (one-fifth of 2,240). Then the consumption of frothing reagent is calculated as follows:

No. of c.c. × S.G. × 5 = lb. of reagent per ton of ore. Consumption of sulphuric acid is obtained thus:

$$\frac{\text{No. of c.c.} \times \text{S.G.} \times \%\ \text{strength} \times 5}{100}$$

= lb. of acid per ton of ore.

FOUR YEARS AS A PRISONER OF WAR

By J. C. FARRANT

(Continued from the April issue, page 221)

The author, a well known engineer, tells of his attempted escape from Döberitz, and relates how he and other prisoners of war were sent to Russia.

Early in 1916 saluting parades every Sunday were in vogue, owing to our troops failing to show proper respect to German officers when marching to and from work.

One day, as we were passing through the German barracks, our attention was attracted by a squad at bayonet practice. The dummies were rigged up in British khaki and French uniforms, the German soldiers grinning and pointing to the dummies, saying "Engländer Caput." Our men resented this and shouted out anything but compliments in broken German to the bayonet squad. The guards used their rifles to get our men on the move. Apparently this disturbance was reported, as upon the next day the dummies were rigged in old German uniforms.

Having finished the church I was eligible for ordinary labouring work again. I carried on with all kinds of work, occasionally "dodging the column." The weather along now was wretched, alternately snowing, freezing, and thawing. Parties would return wet through and with no facilities for drying their clothes. I caught a chill early in March, and reported sick. I was called a "Schwein" by the German doctor, and ordered out to work.

March 8. I dodged the column again, as it was snowing and I felt quite groggy. I kept in hiding until the inspection was over, and then turned in. The next day I again reported sick, and as by this time my temperature was well up, I was admitted into hospital. A man had to be practically down and out before he received medical attention.

The health of the camp generally was very poor, and a large number of men were returning from kommandos with strains from heavy lifting, and heart and lung trouble. Several sick men returning from kommando handed in written statements to the Commandant of brutal treatment they and their comrades were undergoing from the German sentries at the factories. In most cases where prisoners of war were employed by private firms, the sentries were bribed to get as much work as possible from our men, and ill-treatment was general.

April 8. Sixty men refused to work after the given time, and as the following day was Sunday the whole party was stood up at attention for four hours, and all sport was stopped for the whole lager.

April 17. Decided to make a bid for freedom with three others, Kirkaldy, Reinert, and Rumbelow. The day decided upon was Thursday, the 20th, as we intended to take the train during the Easter holidays. However, a big sports programme had been arranged for Friday, Saturday, and Sunday, so we decided to ask Sergeant-Major R., of the Suffolks, who had spent a great deal of time in arranging the sports fête, for his advice, as we knew that if our escape was detected the sports would be stopped. He unhesitatingly told us to go.

The plan for the escape was as follows. To obtain civvy clothes, and travel by train to Reine near the Dutch border, and then cross if we could. The "civvies" were not difficult to obtain, as large consignments early in the war had been sent from home. These had been taken from us and stored by the German authorities. Some of our men were employed in the store, and they rigged us out. A guard was bribed to obtain a time table for us. We had two or three hundred marks between us. We wanted more, so I asked an active service stoker, who was a renowned gambler, to lend me 250 marks. He took off his belt and handed me 350 marks in silver, saying, "It's in a good cause, Towny; hope you get through."

Two lines of barbed wire surrounded the camp. The German guard-house and office were between the first and second lines, which at this point were about 50 ft. apart. Rumbelow, who was the lager electrician, had disconnected one of the electric lights at the place where we intended to get through. He had a permit to go through the gate in the first line in order to attend to the lights round the camp. Guards were posted round the camp about 50 yards apart.

We donned our civvy attire, put on service overcoats and caps, and got through the first gate as helpers to fix up the light that was out. Kirkaldy and Reinert cut the wire and got through without being seen, but when my turn came a guard came back on his beat and wanted to know what we were doing, so we told him we were fixing the light. Putting my words into practice I went up the ladder and unscrewed the globe, bringing it down with me, and telling the guard that we must fetch another lamp from the lager. Rumbelow and I returned to the lager, came back again as soon as the guard moved off, found the cut wire and got through. All four made our way to the road as quickly as possible as we had lost valuable time.

We had a mile and a half to walk to the station. Rumbelow was just purchasing two tickets and we could hear the train coming in when Reinert came rushing up, and in his excitement, shouted out in English, "Get four, you damn fool," following this up with "Noch zwei bitte!" Fortunately no one seemed to have noticed the foreign language, but we missed the train by seconds. We cursed roundly in German, and beat a hurried retreat from the station, got into a dark street, and held a consultation. There was nothing for it but to hang about and catch the next train in an hour's time.

We caught this and reached Spandau, a suburb of Berlin, about 10.15 p.m. We walked up and down the streets of Spandau for two and a half hours, splitting up into pairs. I was carrying a week's provisions for the four of us, and well I knew it by the time our train came in. Reinert bought the tickets and we were just going through the barrier, when the booking clerk tapped on the window. We all thought the game was up, but Reinert had left the change on the counter and the booking clerk had merely knocked to attract his attention. Gad! we were relieved.

We passed through the guards at the barrier, and had not long to wait for the train. It was full up with German soldiers. We tried to get in, but were told only military were allowed in. Just as the train was moving off and we were about to be left, a porter opened the door of a carriage without any light and in we jumped. We repassed our lager with the gap between the lights showing quite plainly, and hoped we should never see it again.

About 3 a.m. we had to change carriages. We got in a second class, in which two German soldiers and two civvies were seated. As soon as it was light, conversation was started by the soldier on my left. What he didn't say about England wouldn't be worth writing, his remarks being endorsed by the other jerries. Rumbelow spoke once or twice, so to keep up appearances I asked him if he knew the time, in German. In trying to speak in an off-hand manner I made a most horrible jargon of it by using the verb "kennen" instead of "wissen." The civvy opposite me cast an inquiring glance in my direction, and as I didn't speak any more he kept his eyes on me for the rest of the journey. I felt every minute he was going to question me. I was jolly glad when we reached Hannover at 6 o'clock in the morning.

As we had missed the fast train, we found that we must change at Hannover, so Reinert asked the time that the Reine train left and also the platform. And then we made a fatal mistake. The train for Reine was not due for an hour, and instead of waiting in the station restaurant, we went up on the platform, where we looked conspicuous in our shabby clothes and dirty boots. On the platform besides ourselves were a German officer and a station official and two or three porters. As we were walking up and down in pairs, I noticed the officer nod in our direction, and speak to the official. Both of them then approached us, and, saluting, asked where we were going. We told them. "What are you?" "Electricians from Berlin going for a holiday." "Kindly produce your passports." As we could not produce them we were arrested. Reinert tried the official with a hundred mark note, but he merely shrugged his shoulders, and said "Ich darf nicht."

We were handed over to the police and subsequently to the military authorities, and put in a small room with three armed guards to await the O.C. At last he came, and after giving in our names, he asked if we were hungry. We replied in the affirmative. Then he said "Have you any money?" We replied "Plenty." To our utter astonishment this remarkable German said he would arrange for some food. "Would we have expensive food or cheap food?" We replied, "The best in the town." Kirkaldy followed this up and made a request for beer, which, however, was not granted. For the next ten minutes we could discuss nothing else than this unparalleled instance of a German officer showing courtesy to British prisoners of war.

We had a topping feed and spent the afternoon waving our hands and giving the glad eye to the girls as they passed our window, which was on a level with the street. Little did they know we were Britishers.

At midnight three guards from Döberitz turned up. They were three beauties. They searched us for arms and knives, and told us they would shoot us at the slightest provocation. We were escorted to the train. As soon as the crowd heard we were escaped British prisoners of war, they became hostile, and crowded round the carriage, shaking their fists and cursing us generally.

We reached Döberitz the next morning. All sports had been stopped as they found we had left the camp half an hour after we had gone. Search parties had been sent out in many directions, but they never thought of the station. We gave in particulars as to how we got our clothes, etc., but we had rehearsed this coming down the line, so none of the boys who helped us got into trouble. We were stripped and put into prison garb, and given wooden clogs, then banged into cells to await our sentence. We were five days on bread and water, awaiting sentence, which was 14 days "strong arrest." This meant bread and water, soup every fourth day, pitch dark cells, and no exercise. And this is where our bid for liberty landed us.

May 7. Taken out of cells and told to pack all our kit, as we were to join the party of 1,000 men who were warned for Russia. We had done 15 days in the cells, and having had no exercise and no light, and with a two-weeks' growth on our faces, we presented a rather forlorn spectacle. The boys had heard we were to be let out, and some of them had prepared a jolly good feed, to which we did full justice. The next item was a shave, and then a bath, after which we felt more like ourselves.

In consequence of our escape, sports had been stopped. Type-written notices were posted up in the barracks by the Germans to the effect that four men had escaped, and had been recaptured, and that they would receive cells in punishment, after which the other English prisoners would no doubt show their disapproval to the four deserters in other ways. One of the men tore down a notice, and gave it to me as a souvenir; I still have it.

May 8. Kept on parade from 8 till 1 p.m., and then the party of 1,000 Britishers slung their home-made packs, and marched out of the camp in fours, while a German cinema operator took photos of them as they filed past. Our packs were very heavy, being composed of everything we possessed, from a frying pan to a housewife and all the grub we could pack; each man had about 100 lb. slung round him in some fashion. We were obliged to make several halts on our way to the station owing to the weight and awkwardness of the packs. A strap would give way, and some unfortunate's burden would be lying in the road, an incident that always provided amusement for the others.

We entrained at Döberitz at 2 p.m., and reached Frankfort-on-Oder at 5 p.m. This lager had a holding capacity of 18,000 men, and was a most dismal place. We were crowded into barracks, which were full of vermin. The next day we were split up in into companies of 500, and served with badges bearing our number and the letters E.K.I. (Engländer Kommando I). A thousand Englishmen from Münster also arrived at this lager.

There were no cooking facilities, and no firewood. Every man had his own "billy" for "drumming up," and as no wood was supplied, there was only one thing to do, that is, to take it. The first thing to go was a high wooden fence round the latrine, the next was the wash-house door, and so on.

Wine was sold at 4d. a glass at the gate. This was the first time that we had been able to purchase intoxicants from the authorities. It was not long before half the camp was distinctly merry. A football appeared on the square, in the middle of which was an arc light. That arc light lasted just about five minutes, the successful shot being proclaimed by loud cheers. Then the guards came and drove us into the barracks. A large bill was presented for the damage done, which was soon settled.

We gave much extra clothing away to the Russians, as the packs were too heavy to carry.

May 11. We entrained in cattle-trucks, about 50 men and packs to a truck. This was worse than when we were first captured. Besides the gear we had brought with us from Döberitz, each man was obliged to carry a section of a tent and six pegs. We travelled in this uncomfortable manner for three days, stopping each day for soup en route.

May 14. We reached Zeren, a small place south-west of the Gulf of Riga. Disentrained, and each man received a 3 lb. loaf. We "drummed up" in a wood and had a meal. At 12 noon we started off up country in a northerly direction. There were 1,000 in this party; the other party of 1,000 had gone to Libau, lucky beggars. We marched with frequent rests till 6 p.m. At each halt, wearing apparel was discarded and left on the road. Balgallon was the name of the place at which we halted for the night. We slept in barns. Next morning every one was feeling stiff and sore, for the bands or straps on the ill-balanced packs had cut into our shoulders.

May 15. Started off at 7.45 a.m. We marched half-an-hour, and rested quarter of an hour throughout the day. The men could not walk longer than half-an-hour without resting, and the column was stretching for nearly a mile. We travelled through forest and swamps, and to add to our trials the mosquitoes were very vicious. Overcoats, underclothes, and even boots were discarded to lighten our packs, but never food or tobacco.

We reached our destination, Kilizeem, at 8 p.m., absolutely knocked. Kilizeem is a small Russian village in the heart of Kurland. Some of the houses had stone floors, but many had nothing but mother earth. They were all crudely built. The barns into which we were taken were ramshakle affairs, but of large dimensions. There were no civilians here, and everything of any value had been taken away.

May 16. The next morning we paraded at 6 a.m. Working parties were told off for cutting wood for the cookers, and the rest of the men were free to do what they liked. Guards were posted at various points to prevent us straying too far. Small parties were soon busy inspecting the interiors of the dwellings. A few kettles were found, which were at once commandeered. One party found a large potato heap at the rear of one of the houses. It was not long before every man was busy digging up potatoes, and we spent the day in boiling and eating them.

May 17. Very cold. Boiling up potatoes. They were very watery things, and didn't satisfy one's hunger. We were running out of grub and tobacco.

May 20. A hundred men, of which I was one, were told off to join No. 1 Company, which was quartered in a farm at the other end of the village. The rest of the men were to go back to the station, and they finally landed at Windau. We arrived at No. 1 Camp at midday, where the men were already under punishment for refusing to work, as the food was insufficient. All their kit had been taken from them, and as our party entered the camp, most of our kits were collared also.

This place had barbed wire round it, and was merely a collection of cow-sheds and barns. The cow-shed that I was detailed to was in use as a temporary hospital. There was about a foot of cow dung and straw on the floor over which some fresh straw had been strewn. As soon as the sanitaets cleared out, we "mucked out" till we came to solid earth. We then secured some planks, and rigged up a shelf on which to sleep. Our place was the best in the lager. There was not room enough for everybody in the sheds, and some of the boys built themselves "kennels," made by laying spits of turf one on another, and using old boards with straw laid on top for a roof. The water in the wells stunk, and we were warned not to drink it. When boiled it was a dark yellow colour, but it was the only water available.

The next day there was insufficient bread to go round. Those men who received no bread were given the day's supply of potatoes for the camp. The feeling among the men was very bitter, as now that we were inside barbed wire fencing we were unable to forage for potato heaps. Added to the hunger was the absence of tobacco and cigarettes.

May 22. The first day's work nearly ended in a riot. The men refused to work; guards threatened two prisoners with the bayonet, but they wouldn't budge. The prisoners were knocked down twice with rifles, but still refused. The rest of the men showed signs of settling the guards, so the guards brought the party back in lager. Paraded for two hours; general hell. No parcel, no tobacco, and damned hungry.

The next day the guards were reinforced and the men worked 11 hours felling trees. The mosquitoes were unbearable. Forty men reported sick, but the doctor sent every man to work without inspecting anyone. The guards used their butt ends frequently. Our N.C.O. in charge told the German officer that if this brutality continued there would be a mutiny.

May 25. About 25 men refused to leave the camp and were stood up all day until 6 p.m. with nothing to eat.

May 26. A new officer, Lt. G., made his appearance to take over. He started shouting as soon as he came on parade, and this precipitated matters. Those at the gate had just marched off, but the rest refused to move. The officer telephoned for a squad of Uhlans. They arrived about 11 a.m., with an active service officer in charge. He ordered the Uhlans to line up in the front of the men, load their carbines, and then made the following announcement, which was interpreted: "You have been sent to Russia as a reprisal. Your Government has handed over to the French 2,000 of our soldiers, many of whom are professional men. They are made to work on the docks, and while they are so employed you will be kept here in Russia and made to work. I will give you one minute to decide, and then I shall order my men to fire." This resulted in the majority deciding to work, but some eight still refused. These men were taken by the Uhlans to some trees outside the lager, and tied up, the Uhlans banging them in their faces with their fists. The next day defaulters were again tied up, and then taken to work, the Uhlans knocking the men about all day.

May 28. This was Sunday. Uhlans turned every man out at 4.30 a.m. After a cup of coffee the men were marched to the forest where they were employed felling trees.

(*To be continued*)

NEWS LETTERS.

PERTH.

March 10.

GOLD OUTPUT.—The rapid decrease in the gold output of West Australia is such as to cause serious thought to those interested. The reasons have already been described. High costs of stores and the shortness and inefficiency of labour are stressed by each chairman at meetings of various companies. The mines with higher-grade ore can keep going on that ; others do so on reduced tonnages at the sacrifice of their lower-grade ore now unpayable. Others again carry on with the help of tributers' crushings and royalties. The smaller mines have been shut down until normal times and costs return.

PROSPECTING.—The most depressing aspect is the want of new mines or ore-bodies. In view of this, a scheme to send out returned miners as prospectors was suggested. As an outcome of a conference, the Minister for Mines nominated a committee of three of which the writer is the chairman to organize and carry on the scheme. The Federal Government granted £5,000 for sustenance of the prospectors, and the Mines Department agreed to supply the equipment. In order that these parties should be able to recognize and differentiate between minerals of economic value and otherwise, it was arranged that they should undergo a preliminary training in learning how to test for the valuable ores. This has been done, and each party, now numbering forty, is supplied with a small collection of typical ore specimens, and the necessary reagents to test them. As a result, several parties have made small discoveries, including gold, copper, lead, bismuth, scheelite, and molybdenite ores, but no great quantity of any of these has yet been found.

The principle is right. It give the soldiers, many of whom will never be able to resume their work as miners, a chance of partly recovering their strength, and what is more, it gives them something to live for. The hope that always stays with the miner that he will "strike it lucky" is such that men, even when weak and ill, crave to return to the bush where they can "fossick about" for a rich leader. As an example, two inmates of the Wooroloo Sanitorium applied to go out under the prospecting scheme. But their application was refused because they were too weak to pass the medical officer. They appealed, saying that if they had to die it would be in the bush and not at Wooroloo. A few friends agreed to make an experiment, and fitted them out with equipment, horse and cart, and three months' food. At the end of that period the writer visited them at their request, and inspected a lode that they had discovered averaging 3 oz. per ton over 36 in. in width. When they started out, they could not walk a quarter of a mile without stopping, whereas now they walk at least ten miles every Sunday, shooting game. Summarizing this, the men are feeling very fit, can do a good day's work, and have the prospect of making sufficient money out of their discovery to keep them going for years.

The old-time prospector with a napping hammer and dish has run over most of West Australia in a slipshod manner. But the committee aim at teaching these prospectors to follow up indications on lines which have been proved to be generally applicable to the ore deposits of West Australia. Mr. Torrington Blatchford, acting Government Geologist, is one of the new school of economic geologists, and aims at helping the prospector. It is therefore to be hoped that a new and progressive type of prospector will grow up, and with him a renewal of prosperity in mining.

WESTONIA. — The Edna May mine at Westonia, which has been a consistent dividend-payer in its short life, is nearly at the end of its days, the ore-shoot having pitched into the Deep Levels. The question of the necessity of these mines amalgamating was dealt with in this column some years ago, but instead of doing so, they have two boards of directors, two managers and staffs, two winding and treatment plants, and not much chance of either paying many more dividends. Whereas, as one property, it might have gone on for a number of years.

Their neighbours, the Edna May Consolidated and Edna May Central companies, are carrying on the same suicidal policy. Unfortunately the reason is that the mines are used as market counters, not business propositions.

LEAD.—The rapid fall in lead from £30 to £23 per ton at Fremantle, less smelting and realization charges, has frightened a number of the small mine-owners at Northampton and they are marking time in case of a fall to £20. At Geraldine, the Surprise lead mine is continuing to open up very well indeed ; the lode at the 100 ft. level is as good as at the 40 ft. level, which, with little picking, produces 100 tons of 75% ore per week from development work. The Geraldine, Geraldine South, Wheal Lily, Wheal Lily North, Wheal Mary, and the Three Sisters mines are being actively prospected. This group of mines is on the Murchison River, 40 miles to the north of Northhampton. The old Geraldine mine is in the bed of the river, and although it was flooded every year, the owners sank the main underlie shaft to 360 ft. on the lode. But with the fall in lead to £10 some thirty years ago, it was shut down and no one has ventured to unwater the shaft since then. The new workings are on a parallel lode, on the bank of the river. The Geraldine South, Wheal Mary, and Wheal Lily are between this and the Surprise lead mine on another line of lode. The Three Sisters, under option to Mr. D. L. Doolette, of Bullfinch, has a big lode formation, through which lenses of high-grade galena are found.

At Ravensthorpe the Government has been running the smelters for the treatment of ore from the surrounding district, but owing to the constantly increasing costs they have reached a limit which will not pay, and consequently the smelters have been shut down.

FILTER-PRESS LITIGATION.—The judgment of Mr. Justice Burnside was given in the Supreme Court of West Australia last month in the case of the Moore Filter Co., of the United States, against the Great Boulder Proprietary, of Kalgoorlie, for alleged infringement of patent. The judge said that plaintiff alleged a breach by defendant of certain letters patent assigned to it by George Moore, the original grantee, in 1907, for an invention for improvements in filter processes for the extraction of gold from slime, dated August 21, 1903. Plaintiff claimed an account of profits derived by the defendant from its alleged breach, or, at its discretion, an inquiry as to damages arising from the use of the processes between 1907 and the date of the issue of the writ. Defendant denied infringement of the patent, which it claimed did not possess the number of necessary elements of validity. It alleged that the patent was the amalgamation of four inventions patented in the United States. The judge said that he found the plaintiff's claims far from clear and precise, but it was impossible to say that they were so bad as to leave a doubt in the mind of the worker skilled in the art of gold extraction as to the invention, which the patentee claimed as his monopoly. The question of novelty raised by the defence was determined by ascertaining whether the combinations claimed were novel for the most part. They were, in fact, novel. All the elements of which they were composed were old, but nobody had previously brought them together in the exact manner of the patentee. It was the novelty of the combination that made the claim. As to the issue whether the combination was useful, he had come to the conclusion that at the date of the grant the plaintiff had not invented what he now said he had. There were difficulties to be overcome which the plaintiff could not foresee, and against which he had made no provision. Some of the combinations claimed might work, but all would not. As to the element of invention, the evidence went to show that the problem still remained, though further improvements might have followed and that the ordinary worker skilled in the art, who was called in to operate the machine, with nothing more than the West Australian patent and specifications, would not, without much experiment, arrive at a successful result. It was contended that the patent was a pioneer and a master patent. The patent was for the principle. In his view the claims disclosed no principle such as was or might be the subject matter of the patent. There was nothing to indicate the claim to the principle. The patent was for a mechanical combination, and it was not alleged that this had been infringed. In his opinion the patent was not valid, and judgment was therefore entered for the defendant company.

TORONTO.

April 10.

PORCUPINE.—The coming season promises to be one of great activity in the mining centres, now that abundance of labour is available, and with the increased equipment installed at the leading mines the output of gold will probably be largely in excess of that of previous years. It is officially stated that milling operations will be resumed at the Dome Mines before the end of April. The mill has a capacity for treating about 40,000 tons per month, which, with ore averaging about $5 per ton, should give a production of $200,000 monthly. A large underground crusher is in process of installation, which will increase the producing capacity. The agreement giving the Dome Mines a one-year option on the Dome Extension property, conditional on the expenditure of $3,000 monthly on development, has been ratified by the Dome Extension shareholders. At the Hollinger Consolidated the large new milling equipment has been put into operation. The management estimates that with some further alterations the capacity of the mill can be increased from 2,800 to 3,800 tons daily or upwards. The working force has been increased to 1,700 men. The mill at the Dome Lake has resumed operations. Ore is being developed at the lower levels of a higher grade than the average in the upper workings. The Davidson is developing an ore-body 34 ft. wide discovered on the 500 ft. level, which shows high assays. The milling capacity will be increased by 150 tons per day by an addition to the mill at a cost of $75,000. The ball-mill and cyanide process will be used. The McIntyre mine has been developed to a depth approximating ¾ mile, the width and gold content of the ore-bodies showing considerable improvement in the lowest workings. The monthly production averages between $140,000 and $150,000, the ore carrying upwards of $10 per ton. Since work was resumed on the Porcupine Crown enough ore has been accumulated to supply the mill for half a year, the grade running between $10 and $11 to the ton. The workings will be continued downward to a depth of 1,400 ft.

BOSTON CREEK.—At the Miller Independence a new central shaft is being sunk to tap the main ore-body at a depth of between 500 and 600 ft. Operations are also being pushed on an incline shaft on the deposit down to a depth of 200 ft. High-grade ore containing gold tellurides is stated to occur in considerable quantities. At the Colter, an ore-body indicated to be 28 ft. wide has been cut by diamond-drilling. Drilling operations have been started on the Cullen-Renaud adjoining the Colter. A group of three claims owned by Dr. W. Arnold and J. A. Hughes has been purchased by Mr. Savage of Buffalo.

COBALT.—The Nipissing during February produced silver to the value of $243,176, but made no shipments. No new veins were discovered, but all producing faces continued to be satisfactory. At the Ophir, which is operated by the Nipissing under option, favourable results are attending development, a high-grade ore-shoot having been discovered. The annual statement of the Beaver Consolidated shows earnings of $393,385 and operating costs of $207,331. Receipts from all sources were $467,997. The amount at the credit of profit and loss was $912,919. The production for the year was 385,042 oz. of silver, as compared with 372,973 oz. the preceding year. The annual report of the La Rose shows a considerable falling off in production, the gross value of which was $295,898, as compared with $371,583 in 1917. Net profits were $45,544 as against $71,247, and the total surplus $456,046 as compared with $509,927 for the previous year. Operations at the Adanac continued favourable, a quantity of high-grade ore in addition to a large tonnage of mill-rock having been discovered. The management is contemplating the construction of a new mill of about 75 tons capacity.

SUDBURY.—The Mond Nickel Co. has curtailed operations at the Coniston smelter and the Worthington and Levack mines, all three plants having been reduced to one shift per day. The International Nickel Co., which adopted a policy of curtailment two months ago, is now only working at one-third capacity. It is stated that neither of the companies has been able to effect any sales of their output since the signing of the armistice, and that no resumption of their activities on the former scale will take place until the metal market improves.

CAMBORNE.

THE GOVERNMENT AND CORNISH MINES.—As was foreshadowed in the last issue, the Treasury vetoed the departmental recommendations of state financial assistance for those companies which are struggling against adverse conditions created largely through Government action, and we fear there is no other course but for these particular mines to close down speedily or materially curtail operations. It is true that the Joint Industrial Council has demanded an interview with the Prime Minister, but Mr. Lloyd George is, we fear, much too busy to devote any time to what must be to him a very small matter. As Mr. Moreing bluntly put it at the annual meeting of the Chamber of Mines, "they had to help themselves," and if this is not possible, then the prospects of the industry are not too cheerful. Already Grenville and Tincroft are reported to have raised capital by means of loans secured on the plant.

The telegram from the Board of Trade read: "Regret Government cannot see their way to give financial assistance to Grenville or other Cornish tin mines. Full inquiry into general position and prospects of tin-mining industry will be undertaken shortly." Mr. C. V. Thomas neatly summed up this when he said, "After the patient is dead, the Government will consider steps by which he may be kept alive." This naive promise of an inquiry under such circumstances is positively enough to make angels despair of a Government department, and it is clearly only a sop to lessen temporarily the dissatisfaction of the industry. When completed, the report will doubtless be pigeon-holed like those of the innumerable commissions now sitting to solve other awkward matters for the Government. The Chamber of Mines should advise the industry not to interest itself in the matter, for the provision of data will be a waste of time and effort. All the information necessary to decide on a policy is already in the hands of the Government, who have only to consult the records of the Department for the Development of Mineral Resources, and of the Imperial Mineral Resources Bureau.

INCOME TAX REFORM AND CORNISH MINES.—The industry has now the opportunity afforded it of presenting evidence to the Royal Commission on Income Tax (which is investigating the incidence of this tax in all its aspects) of some of the anomalies of this tax as it affects Cornish mines. This is a matter vitally affecting the industry, as many companies are bearing a burden to-day which in equity they ought not to bear. There are two outstanding anomalies that ought to be tackled. First, we have the fact that shaft-sinking for taxation purposes is regarded as a capital charge, and no allowance is permitted annually by way of writing off, even although the ore around the shaft is exhausted and the shaft is only of service for ventilation purposes. The sinking of a shaft is a necessary work and as much a working charge as the driving of a level, and justice demands that a percentage written off each year should be permitted as a reasonable charge against profits. Then we have the fact that no allowance is permitted for the wasting nature of a mine as an asset. It is true that when a mine is purchased or leased, its approximate value is seldom known. But undoubtedly as the ore is extracted the mine becomes of less value, and an allowance should fairly be permitted. It is not beyond the wit of man to lay down a formula which would be fair both to the mine-owners and to the Revenue authorities. It is to be hoped, therefore, that the Chamber of Mines will make representations to the Commissioners on these points. The Chamber successfully handled the Excess Profits Duty appeal, and this is a much more important matter from a general point of view. It may be urged that the Institution of Mining and Metallurgy may present evidence to the Commissioners on behalf of a world-wide mining industry, but that body is unable to put Cornwall's case so well as can the Chamber; and, indeed, Cornwall would be overshadowed. Ours is a case much more likely to command sympathetic treatment, seeing that it is a home industry and in need of special consideration.

CHECK-WEIGHING IN VARIOUS INDUSTRIES.—This Bill, recently introduced into the House of Commons by the Labour Party and accepted by the Government, does not specifically refer to the tin-mining industry, but its provisions may be extended when under examination in Committee, and it is quite possible that tributing may come within its orbit. The Bill aims at enabling the workers to check results when they are paid by weight or measurement.

TIN TICKETINGS.—At the annual meeting of the Chamber of Mines, Mr. Moreing referred to the high smelting charges which the mines have had to bear for the past year or two—on some occasions well over £30 per ton of concentrate—when selling their produce through the Ticketing. The only smelter present, Mr. F. D. Bain, could not deny the impeachment, but explained that it was due to abnormal conditions. The fact is that the tin miner has not only to bear the cost of smelting, plus a fair percentage of profit, but the smelter fixes on him the necessary margin to cover against fluctuations in the price of tin. The only remedy is to substitute the method of sale by contract as recommended many times in these columns; the miner will then be paid for the actual content of the concentrate at current market prices, less a fair charge for smelting.

CHINA-CLAY COMBINE.—A company under the title of English China Clays, Ltd., with a nominal capital of £2,000,000, has been formed to acquire the interests of three of the largest china-clay producing firms in the West of England, Messrs. Martin Bros., Ltd., the West of England & Great Beam Clay Co., Ltd., and the North Cornwall China Clay Co., Ltd. It is not at all improbable that the producers not concerned in this scheme may be induced to join later on. Large combinations of this character, and the consequent reduction in administration costs, will to some extent help to offset the increased operating costs.

NORTH OF ENGLAND.

There is little local news of a technical character to communicate this month. The owners of lead and zinc mines are anxiously awaiting the decision of the Board of Trade in reference to the request for an inquiry into the position of the home mines. Your Cornish correspondent no doubt will deal with the tin position, but I understand that the Government has refused any help to this section of the industry. I have good authority for saying that the Government has no intention of extending either the Wages Refund or the Output Bonus. The lead and zinc mine-owners should definitely realize that all the talk of the Prime Minister concerning the fostering of home production is talk and nothing else, and that neither he, nor any Government department cares a jot if the mines are compelled to suspend operations. Some of us have been fearing the worst, and that fear has been realized. The only satisfaction to be derived from the knowledge—a gloomy satisfaction—is that we know at last where we stand. It is a difficult, not to say distressful, situation in which we now find ourselves. If ever there were an industrial position which demands relief, even if the relief had to come from the taxpayers, it is ours.

Consider the facts with which we are faced. Firstly, the wages represent from 60 to 80% of the cost of production, but the Government has fixed the rates and no saving can be effected under this heading. Secondly, materials used in mines are steadily rising, especially iron and steel replacements (the minimum price of Cleveland pig-iron has risen 50s. above the official maximum price). Thirdly, the price of lead has fallen heavily owing to the Government being the holder of enormous stocks which apparently it has made no efforts to sell at cost price. Fourthly, zinc has fallen nearly £20, and smelters are confronted with extravagant costs and cannot, therefore, give much for the ore. Fifthly, the Government is the buyer abroad of enormous quantities of blende under contracts that have still ten years to run, and they are thus in the market and are selling against us. And, finally, the Government is still buying lead and zinc at high prices, and is consequently subsidizing the producer abroad.

I cannot learn at what rate the Australian concentrates are being sold to the smelters, but it is probably much below the actual cost, and the fact is that the home smelters are unwilling to purchase home blende at any price. At one mine I learn that they could not get any offer for their output owing to the large arrivals of Colonial ore.

We all want to encourage trade with the Colonies, but the miners here have certain elemental rights that should be guarded. I imagine the position to be somewhat as follows. The Treasury says: "We have lead, zinc, and zinc and tungsten concentrates which we have bought at high prices. We have to carry out contracts, and we must continue to take delivery. We are, however, short of cash, and, therefore, are prepared to sell at any sacrifice to make as good a cash position as we can. If we directly or indirectly help the mines, we set up against ourselves competition which may result in even lower prices than we are now obtaining. We have engaged to purchase blende for ten years at a fixed price from abroad, and there seems no keen demand for it. We can probably make the smelters take it, if they cannot get the better quality home ores. It is obvious, therefore, that it is to our advantage to stop the home production. In any case, this industry is small and commands little voting power. By selling our lead, zinc, and blende at under cost prices we are pleasing, first, the smelters, and secondly, the consumer, so the pain we feel at ruining our little home mines will not prick our consciences for long. It is true that we have kept their prices down during the war and prevented them from making any substantial profits, but after all we were doing this for the good of the country. We were unable to resist the pressure of the large interests, so that it is all the more necessary to take a stand firmly with this inconsiderable group and show the public that we are effectively guarding the public purse. For instance, the arrears of the wages under the Sankey Award has cost us £7,000,000, paid to the highest remunerated section of the community, but they have well-organized voting power, and we must keep them satisfied. On the whole we need not worry about these mines, and if the question is raised in Parliament we can simply say that we must draw the line somewhere." This appears to be a fair statement in the case as it is viewed by the Treasury officials, who are probably shaky as to what blende and galena may be.

I wonder whether it has occurred to these employees of the State that houses and villages are to be wrecked, that the efforts of years are to be destroyed, and that in many cases ruin will follow their decision.

I feel all the more bitter about it because I know that the conditions are largely temporary, that in a period measurable by months the Government stocks will be liquidated, and that the markets for our ores will become fairly normal. It is, however, unfortunate that mining, as we know it in districts like ours, is not an industry that can in most cases suspend operation for even the shortest of periods without incurring very serious loss. The pumps have to be kept going by a staff of men, and few companies are in a position to meet this expenditure for long. The operating staffs would be dispersed, and in a year's time it would be difficult to recover the labour. The actual employees will not suffer very seriously, as they will get their donation, and can sit on the timber piles at the mines for three months at wages that will enable them to eke out an existence. It may possibly suggest itself to the Government department that it would be more economical to pay the companies 25s. per man than to give the workmen 40s. per week at the Labour Exchange, but it is more possible than probable.

LETTER TO THE EDITOR

The Function and Training of the Mining Geologist.

The Editor :

Sir—Professor Cullis' article in your October issue will interest most mining men, but particularly Associates of the Royal School of Mines.

Not so very many years ago geological advice was rarely sought by metalliferous mining companies, no doubt owing to the very divergent views held by prominent geologists upon the genesis of ore deposits. The great improvement in the state of our knowledge during the last 20 years is reflected in the changed attitude of mining men toward this subject of mining geology and in the employment of geologists by mining companies.

Periodical examinations by a visiting geologist may suffice to deal with questions affecting the genesis of the deposits as well as to indicate the directions in which exploration should proceed ; but there are many cases where continuous study of the faces in progress should be prosecuted so that no structural or petrological changes shall be missed. It is impossible to say how much ore is missed through lack of attention to the geological evidence in a mine, but the discovery of new deposits, and the extensions of known deposits has been recorded in various geological bulletins and also in transactions of various mining engineers' societies, geological transactions, and technical periodicals.

We therefore have the consulting geologist, the mine geologist, and to these we must add the prospecting geologist. The aim of each is to find new deposits, and to indicate the probable forms of extensions of existing deposits. The importance of such work, when carefully conducted, is now generally recognized, and the new course of study described will be welcomed, though its utility will not be so general as the courses in mining and metallurgy.

It is to be hoped that mining companies in general will obtain geological advice while the ore supply is good and increasing, instead of waiting until a failing supply impresses upon the management the necessity for advice as to the hope of extensions of the ore-body being found by judicious development. A geological report which comes as a delicately worded obituary notice rarely serves a good purpose ; an early report either saves subsequent heartburning or enables development to be carried out with expedition and success.

In the scheme of training outlined, I do not think that modern languages should be made more prominent than for the sister courses of mining and metallurgy. If these languages be required for the prosecution of special studies, by all means include them, but if they be specified merely to widen the field for employment, I should prefer to see that left to the individual himself. A four-years' course, which has already been preceded by several years of preparatory work, is a pretty expensive vocational education, and the graduate may have to be content with a moderate salary in a subordinate position for several years before commencing to reap the reward of his industry.

A good general knowledge of mining methods is essential, otherwise the geologist would be all at sea in his work. Metallurgy has not the same direct bearing upon his work, but a knowledge of the principles of the subject is necessary to keep him in touch with the revenue-producing end of the industry. Also, it should be mentioned that many mining associates have become successful metallurgists, and vice versa. It is, in fact, difficult to foretell what will be the direction in which the graduate will turn with most success.

In the details of subjects it may be well to mention that structural features should be studied in mine workings wherever possible. Petrological and mineralogical features claim so much attention that structural features are apt to be overlooked.

In petrology, the examination of rocks from mine workings all over the world should be made a feature of the work. If possible the positions from which the rock specimens were taken should be indicated on a mine plan, preferably a geological plan. With this end in view, I would suggest that a collection of rocks should be made illustrating the geology at various well-known mines, more especially those where the geology has been described in technical literature which is accessible to the student. No doubt old students would assist by forwarding specimens and plans. This work would then be kept closely in touch with the course of lectures upon the occurrence and genesis of ore deposits.

Finally I would suggest that it is desirable not to narrow the usefulness of the new department by making the course too long or too severe in subjects which after all do not matter greatly to the mining geologist.

A. Jarman.

Auckland, New Zealand,
February 20.

PERSONAL.

DR. J. MACKINTOSH BELL has resumed mining practice and has gone to Canada.

JAMES P. BEST is expected from Nigeria.

ARNOLD BRADLEY has been appointed Deputy Controller of Mines in German East Africa.

ALEXANDER O. BROWN has been appointed manager of Mina Tinto y Santa Rosa, Spain, for United Alkali Company.

LT.-COL. JAMES CROSS BROWN, D.S.O., has been demobilized, and has been appointed commercial manager for Mason & Barry, Ltd.

B. D. BUSHELL has been appointed manager of Daggafontein Mines.

GELASIO CAETANI was in London last month.

W. H. R. CHAPPEL is returning to the Federated Malay States

ALEXANDER COLLEDGE has been demobilized from the Royal Air Force and has commenced practice as a consulting engineer in London.

ALLAN A. DAVIDSON is here from Nigeria.

FRANCIS DRAKE has returned from South America.

J. JERVIS GARRARD has been elected president of the Geological Society of South Africa.

DONALD GILL has left for Siberia.

R. D. GILL has been elected president of the Cornish Institute of Engineers.

Major H. HANNAY, R.E., has been demobilized and is returning to Nigeria.

Dr. J. A. L. HENDERSON is going to Canada

J. M. ILES is here from Nigeria.

W. R. INGALLS has retired from the editorship of the *Engineering and Mining Journal* and has taken an office at 115 Broadway, New York

Major P. S. INSKIPP has been appointed a director of the British South Africa Company.

A. F. KEENE has been appointed consulting engineer to the Goldfields American Development Co., Ltd

GEORGE C. MACKENZIE, recently with the Canadian Department of Mines, has been appointed manager for the Electric Steel & Engineering Co., Ltd., Welland, Ontario.

D. H. MCDOUGALL has been appointed one of the representatives of the Canadian Mining Institute on the Canadian Engineering Standards Committee.

ROBERT M'LAREN is the new president of the Mining Institute of Scotland.

C. T. NICOLSON, of the Bucyrus Company, is here from America.

H. W. PRIDGEON has been appointed manager of West Springs.

MALCOLM ROBERTS, manager of the Aramayo-Francke group of mines in Bolivia, is in England.

FRED SEARLS, Jr., was in London last month on leave from Germany.

RALSTON C SHARP has returned from Mexico.

S. J. SPEAK is on his way back from Rhodesia.

G. GORDON THOMAS, manager for the Kano (Nigeria) Tin Areas, Ltd., expects to arrive in England late this month or early in June.

D. M. THOMSON has been demobilized, and has left for Nigeria to resume his position with the Naraguta Company.

H. L. VENABLES is leaving for Bolivia.

A. B. WATSON is expected from Nigeria next month.

J. J. WESSELS has been elected president of the South African Association of Mine Managers.

Major HAROLD WHITTINGHAM has left for Sardinia.

POPE YEATMAN has moved his office from 60 Broadway to Room 708, 111 Broadway, New York.

VICTOR ZIEGLER has resigned as professor of geology and mineralogy at the Colorado School of Mines and has opened an office at 411-415 Empire Building, Denver

---

T. W. WELLSTED, a partner in the firm of Bewick, Moreing & Co., died last month. His share in the firm's work was on the business and financial side.

H. R. HANCOCK, inventor of the Hancock jig, and for many years manager of the Wallaroo & Moonta mines, died on January 15. His son, H. Lipson Hancock, succeeded him as manager in 1898.

THOMAS MULLETT, secretary of the British Broken Hill company and the Cornwall Tailings company, and London secretary of the Broken Hill South, was killed in a motor-bus accident in the City last month.

JOSEPH TAMBLYN died at St. Day, Cornwall, on April 25. After being connected with Dolcoath for many years, he went to Spain, but later returned to his native county. His last positions were as manager of East Pool and Condurrow respectively.

A. W. COX, one of the original shareholders of the Broken Hill Proprietary, died at the beginning of this month. To the general public he was known as "Mr. Fairie," under which pseudonym he had a long, brilliant, and honourable career as an owner and breeder of race-horses.

SIR FRANK CRISP, the leading London solicitor devoting his attention to company law, died on April 30, aged 77. Besides being a sound lawyer, he was a distinguished microscopist and botanist, and his gardens at Henley-on-Thames were of extraordinary beauty and scientific value.

J. E. JOHNSON JR. was killed in a motor-car accident on April 4, at Hartsdale, New York. He was a leading American authority on iron mining and iron metallurgy, and his books on the blast-furnace have been greatly appreciated both in his own country and in the British Empire.

TRADE PARAGRAPHS

SANDYCROFT, LIMITED, of Chester and London, have recently completed a second geared compressed-air hoisting engine, for use at an auxiliary shaft at one of the Indian gold mines. The cylinders are 18 in. in diameter by 3 ft. stroke, and work at a pressure of 60 lb. per square inch. Cylinders of 20 in. diameter can be substituted if it is desired in the future to increase the power developed. The engine crank shaft runs at a speed of 105 r.p.m., which is reduced by means of cut gearing to 35 r.p.m. at the drums. The main engine frames are of cast iron of deep box section, and have a wide base with a beading all round to catch drippings of oil and water. To overcome the difficulty in providing sufficiently deep and solid foundations underground, the whole engine is carried on an underframe built up with heavy rolled steel joists. The main frames, underframe, and drums are made in sections in order to pass down the shaft. The engine has two drums, one keyed on to the shaft, and the other bushed with gun-metal to run loose on the shaft. The second drum is provided with a clutch. The drums are built up with steel plate sides and lagging carried by rolled steel channel arms, which are fitted into cast iron centre bosses. The clutch on the loose drum is of cast steel of the multiple-tooth type, and has been made of large diameter to minimize the rope error. The sliding part of the clutch is fitted on a hexagon formed on the drum shaft, and is operated by a hand wheel and screw on the driver's platform. The drum shaft is driven from the crank shaft by cast steel machine-cut Citroën treble helical gearing. Each drum is provided with a cast iron brake rim having a wide tread to compensate for the low coefficient of friction obtained in underground conditions. The drum brakes are of the suspended post type. They are built up with curved steel plates, cut to shape and fitted with poplar wood blocks, backed by rolled steel channels. brakes are applied by dead weights lifted by auxiliary compressed-air engines. The brake engines are fitted with cataract cylinders, and floating lever valve gear operated from the driver's platform. The brake posts are anchored to cross-channels carried on the underframe. The crank discs are of cast iron, and are provided with steel band brakes, lined with wood blocks, working on the turned rims. These brakes are operated by a foot lever and a hand wheel and screw on the driver's platform. The cranks, gear wheels, and fast drum are all held on their shafts by tangential keys. The bearings for the drum and crank shafts are cast with the engine frames, and are fitted with four-part cast iron shells lined with white metal. The side shells are adjustable by means of wedges and screws. Both shafts are provided with centre bearings mounted on a cast iron stool carried on the underframe. A dial depth indicator is driven by each drum by cut gearing. The connecting rods have solid ends for both crank and crosshead pins, and are fitted with gun-metal steps adjustable by wedges and screws. The guides are cast with the engine frames, and are bored for the crossheads, which are of cast steel and are fitted with adjustable cast iron slippers. Heavy mild steel plates are bolted to the back of the crossheads, through which the piston-rods pass. The rods are held by nuts on each side of these plates, so as to provide a simple means of equalizing the clearance of the pistons as the connecting-rod brasses are adjusted for wear. The piston rods are of steel. The cylinders are cast separate from the valve chambers, which are formed in the cylinder covers, the front covers being flanged to bolt on to the engine frames. The admission and exhaust valves are arranged at an angle of 60° from the horizontal, and open into hemispherical spaces which form the cylinder ends. The pistons are of cast iron, cored hollow, and are in the form of two hemispheres to fill up the cylinder ends. By arranging the valves at an angle and to open direct into the spherically shaped cylinder ends, the clearance is reduced to a minimum. The admission and exhaust valves are of the single-beat balanced drop type. They are made of special quality cast steel, and the valve seats, which are of the same metal, are forced into the chambers in the cylinder covers. The valve spindles are not packed where they pass through the covers, but are fitted in long gun-metal bushes. The spindles have a number of shallow grooves turned in them, and are ground to fit in the bushes. Grease is forced into the grooves through radial holes arranged for the purpose. Thus air-tight joints are made without the friction caused by packing. The valves fall on to the seats by their own weight, accelerated by springs, and are lifted by hardened steel cams, one to each valve, having blades tapering from each end to the centre of the cam. One blade is for running forward, and the other for running backward. The cams are so shaped as to let the valves down on the seats without shock. The engines are reversed by sliding the cams along feather keys on the side shafts. The reversing levers are worked by an auxiliary compressed-air engine fitted with a cataract cylinder and floating lever valve-gear, which is operated from the driver's platform. The operation of the valve gear causes the reversing engines to slide the cams into the position corresponding with that of the reversing handle, and they are locked by the cataract cylinder in that position until the handle is again moved. The lift of the valves can thus be varied, while the lead remains constant. The part of the tappets which contacts with the cam is formed with a hardened steel ball rolling in a nest of small balls, thus minimizing friction during both circular and longitudinal movement of the cams. The rods connecting the tappets to the valve levers are fitted with gun-metal bushes in both ends, which are adjustable for taking up wear without altering the length of the rods. The cylinders are lubricated by tallow cups, and the valve spindles by Stauffer grease cups. In addition to these, an oil reservoir having branch pipes to each admission valve is fitted to each cylinder. The oil reservoirs are fitted with pistons and non-return ball valves, and are connected by pipes with the compressed-air main. Air is admitted to the reservoirs by a spring-controlled push-button valve arranged on the driver's platform by means of which the cylinders and valves can be flooded with oil at the commencement of each wind, the oil being automatically cut off when the button is released. The specification emphasized the importance of the clearance spaces in the cylinders and valves being reduced to a minimum. By arranging the valves as described it has been possible to keep the clearances down to less than 2½% of the total cylinder volume.

METAL MARKETS

COPPER.—The general revival of interest in this article continues, and some good business has been reported from time to time in electrolytic in this country, in which it is understood some of the important wire-drawers participated. In addition, a fairly steady inquiry for smaller quantities has been seen from the rank and file of consumers, and the general tendency seems to point to a gradual rehabilitation of industry in this line of business. The demand for manufactured copper has been very well maintained, and values of this commodity have ruled steady. A feature of the inquiry for this class of metal continues to be the demand for copper plates for locomotive building, and it is under-

DAILY LONDON METAL PRICES: OFFICIAL CLOSING PRICES ON
Copper, Lead, Zinc and Tin per Long Tons; Silver

	SILVER	COPPER			LEAD	
		Standard Cash	Standard (3 mos.)	Electrolytic	Best Selected	Soft Foreign
April	d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
11	[illegible]	76 10 0 to 76 15 0	76 10 0 to 76 15 0	82 0 0 to [illegible]	82 0 0 to 81 10 0	24 10 0 to 24 0 0
14	[illegible]	75 [illegible] 0 to 76 0 0	75 10 0 to 76 0 0	81 0 0 to 81 [illegible] 0	82 0 0 to 81 10 0	24 10 0 to 24 0 0
15	[illegible]	77 5 0 to 77 10 0	77 5 0 to 77 10 0	81 0 0 to 81 10 0	81 0 0 to 81 10 0	24 10 0 to 24 0 0
16	[illegible]	76 15 0 to 77 0 0	76 15 0 to 77 0 0	81 0 0 to 81 10 0	81 0 0 to 81 10 0	24 10 0 to 24 0 0
17	[illegible]	76 5 0 to 76 15 0	76 5 0 to 76 15 0	81 0 0 to 81 10 0	81 0 0 to 81 10 0	24 10 0 to 24 0 0
22	[illegible]	76 0 0 to 76 10 0	76 10 0 to 76 15 0	81 0 0 to 81 10 0	81 0 0 to 81 10 0	24 10 0 to 24 0 0
23	[illegible]	75 10 0 to 75 15 0	76 0 0 to 76 5 0	80 10 0 to 81 0 0	81 0 0 to 81 10 0	24 10 0 to 24 0 0
24	[illegible]	75 5 0 to 75 10 0	75 10 0 to 75 15 0	80 10 0 to 81 0 0	81 0 0 to 81 10 0	24 5 0 to 23 15 0
25	[illegible]	75 10 0 to 75 15 0	75 15 0 to 76 0 0	80 10 0 to 81 0 0	80 10 0 to 81 0 0	24 5 0 to 23 15 0
28	[illegible]	76 15 0 to 77 0 0	77 5 0 to 77 10 0	80 10 0 to 81 0 0	80 10 0 to 81 0 0	24 5 0 to 24 0 0
29	[illegible]	76 5 0 to 76 10 0	76 10 0 to 76 15 0	80 10 0 to 81 0 0	80 10 0 to 81 0 0	24 10 0 to 24 0 0
30	[illegible]	76 5 0 to 76 10 0	76 10 0 to 76 15 0	80 10 0 to 81 0 0	80 10 0 to 81 0 0	24 10 0 to 24 0 0
May						
1	[illegible]	76 0 0 to 76 5 0	76 5 0 to 76 10 0	80 10 0 to 81 0 0	80 10 0 to 81 0 0	24 10 0 to 24 0 0
2	[illegible]	75 10 0 to 75 15 0	75 10 0 to 75 15 0	80 10 0 to 81 0 0	80 10 0 to 81 0 0	24 10 0 to 24 0 0
5	[illegible]	75 15 0 to 76 0 0	76 0 0 to 76 15 0	80 0 0 to 80 10 0	80 10 0 to 81 0 0	24 10 0 to 24 0 0
6	48 9/16	76 10 0 to 76 15 0	76 10 0 to 77 15 0	80 0 0 to 80 10 0	80 0 0 to 80 10 0	24 0 0 to 24 5 0
7	[illegible]	76 [illegible] 0 to 76 10 0	76 10 0 to 76 15 0	80 0 0 to 80 10 0	80 0 0 to 80 10 0	24 2 6 to 24 7 6
8	[illegible]	76 10 0 to 76 15 0	76 15 0 to 77 0 0	80 0 0 to 80 10 0	80 0 0 to 80 10 0	24 2 6 to 24 7 6
9	[illegible]	76 15 0 to 77 0 0	77 0 0 to 77 5 0	80 0 0 to 80 10 0	80 10 0 to 81 0 0	24 0 0 to 24 5 0

stood that where hammered plates are concerned the time required for delivery by some makers is round about four to five months. Business with India, too, has shown a satisfactory expansion, and a fairly steady trade has been done both in copper squares and in yellow metal. While on this subject it might be mentioned that the stock at Bombay on February 28 of copper braziers amounted to 165 tons, compared with 654 tons at the same date in 1918, 1,962 tons in 1917, and 3,270 tons in 1916. On February 28, 1919, the stocks there of yellow metal braziers were 659 tons, compared with 216 tons in 1918, 682 tons in 1917, and 1,498 tons in 1916. It would therefore seem that there is room for a considerable business if the old level of stocks is to be maintained. Japan appears to continue shipping this class of material to India, the imports at Bombay between March 17 and 20 amounting to 60 tons of copper sheathing, yellow metal sheets, and yellow metal sheathing, while between March 25 and 27, 27½ tons of yellow metal sheets and yellow metal sheathing were imported. Values of copper in this market have shown on the whole rather an easier tendency during the month of April, which seems to be mainly due to the position in America. The stocks of copper held in this country by the Government, exclusive of old metal and scrap, on April 1 amounted to 48,702 tons, which showed a decrease compared with the figures of a month earlier of 2,671 tons. The fact, if considered as a bull factor, was however ignored by the market. An interesting feature in regard to the quotations for both standard copper and refined in this country is that prices now show a contango or premium on forward delivery metal compared with prompt, while at the end of March future delivery was obtainable at a discount. This fact naturally implies a more healthy tone in the market. In America the same conditions rule as regards quotations, which are stiffer for forward than for prompt. Output returns there show a considerable variation, but taken as a whole the production of the mines is being considerably curtailed, and this should soon be reflected also in the returns of refineries.

Copper ores have been idle and buyers show little interest. Those containing 15-25% are quoted at 11s. 9d. to 12s. 3d. nominal per unit and per ton of 20 cwt.

Average prices of cash standard copper: April 1919, £77. 7s.; March 1919, £76. 17s. 7d.; April 1918, £110. 5s.; March 1918, £110. 5s.

The March imports of copper were 14,406 tons against 19,203 tons last year.

TIN.—The standard market has seen some moderate fluctuations during the month, although these have not been over a particularly wide range. Early in April prices declined very rapidly, cash coming down to about £219. 15s. and three months to £217. 15s. This sharp fall was largely due to fears that the control over prices in the East had been abandoned, as a report came through of a sale of tin at a price much under what had hitherto been held for. It ultimately proved that the business in question had been concluded by an outside seller and had no special significance, whereupon confidence in the position was restored, and values recovered to about £227. 12s. 6d. cash, and £225. 2s. 6d. three months. Since then the market has varied from day to day within comparatively narrow limits, but on balance values are several pounds lower than they were at the end of March. Business in the article in this country has on the whole been fairly good with the consuming trades. Latterly the tinplate trade has been rather quieter, and this has been reflected in the inquiry for tin, but there seems now to be signs of renewed activity in tinplate, and this will no doubt have its effect in the market for the raw material. The demand for English tin has in the main been rather quiet, despite the fact that it could be exported to many destinations without licence.

The position in America shows no change. There is still an embargo on imports into that country, and this it appears must continue until the Government stocks there have been wiped out. It has even been reported that it might go on even longer than this, presumably to protect those who have bought the high-price tin. The latter contingency, however, is not considered probable. Meanwhile America seems to have been buying in the Straits with a view to having the metal shipped to London or to Vancouver to await there until such time as the ban on imports into the United States is removed. At present the authorities there seem to be doing everything possible to get the stocks reduced, and it is understood that they have requested some private smelters to refrain from selling meantime, with the object of assisting them in their efforts. China continues to hold for high prices, and there are no signs yet of the holders there being anxious to liquidate their stocks.

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter)	Standard Tin Cash	Standard Tin 3 mos
£ s d £ s. d.	£ s d £ s d	£ s. d £ s. d.
36 5 0 to 36 0 0	225 10 0 to 226 0 0	223 15 0 to 224 0 0
35 10 0 to 35 0 0	222 10 0 to 223 0 0	219 0 0 to 219 10 0
35 15 0 to 35 0 0	222 10 0 to 223 0 0	219 10 0 to 220 0 0
35 15 0 to 35 5 0	224 0 0 to 224 5 0	221 5 0 to 221 10 0
35 0 0 to 35 5 0	224 10 0 to 224 15 0	222 10 0 to 222 15 0
35 0 0 to 35 5 0	226 10 0 to 227 0 0	224 15 0 to 225 0 0
35 0 0 to 35 5 0	225 5 0 to 225 10 0	223 15 0 to 224 0 0
35 0 0 to 35 5 0	225 10 0 to 225 15 0	224 5 0 to 224 10 0
35 0 0 to 35 5 0	226 10 0 to 226 15 0	225 0 0 to 225 5 0
35 10 0 to 35 15 0	225 10 0 to 226 0 0	224 10 0 to 225 0 0
35 10 0 to 35 15 0	225 15 0 to 226 0 0	224 15 0 to 225 0 0
35 10 0 to 35 15 0	226 5 0 to 226 10 0	225 5 0 to 225 10 0
35 5 0 to 35 10 0	226 10 0 to 227 0 0	226 0 0 to 226 10 0
35 5 0 to 35 10 0	226 0 0 to 226 10 0	225 15 0 to 226 5 0
35 0 0 to 35 5 0	226 15 0 to 227 0 0	227 0 0 to 227 5 0
34 10 0 to 35 0 0	227 15 0 to 228 0 0	228 0 0 to 228 5 0
34 15 0 to 35 5 0	228 10 0 to 228 15 0	228 5 0 to 228 10 0
34 15 0 to 35 5 0	229 10 0 to 229 15 0	228 5 0 to 228 10 0
34 15 0 to 35 5 0	231 10 0 to 232 0 0	229 10 0 to 229 15 0

The average prices of cash standard tin: April 1919, £225. 6s. 6d., March 1919, £236. 18s. 5d.; April 1918, £329. 18s. 1d.; March 1918, £318. 15s.

The imports of tin for March, 1919, amounted to 2,725 tons, compared with 123 tons last year.

LEAD.—This market now shows signs of assuming something like a pre-war aspect so far as consumers' demands are concerned. The inquiry from the trade has seen a very considerable revival and has well maintained its increased importance. A certain amount of inquiry for export has also been in evidence, and the demand generally both for home and abroad should expand when the various much talked-of building schemes get into operation here, and when business can be more freely conducted with Continental neutrals. In spite of this, however, values on the month have declined, but at the present basis the market appears to have a more stable tone. The Government stocks of soft pig lead on April 1 amounted to 96,456 tons, or a decrease of 3,607 tons since the beginning of March. There has been meantime no particular selling pressure from America, and it is believed in some quarters that Spain cannot well afford to sell at prices now ruling here, and whether Australian producers will continue to do so is regarded as doubtful.

The average price of soft pig lead for April 1919, was £24. 8s. 7d.; March, 1919, £26. 16s. 11d.; April 1918, £29; March 1918, £29.

The March imports of lead were 23,522 tons, compared with 16,231 tons last year.

SPELTER.—For the greater part of the month this market has been rather quiet, the demand from the consuming trades, particular the galvanized sheet trade, having been very slow to revive. The same remark appears to apply to the position in America. Great hopes were entertained that when the steel price question was settled a good demand for galvanized materials would ensue, and consequently the demand for spelter would revive. So far, however, there are no signs of a satisfactory settlement being arrived at in regard to the steel question, and consequently the inquiry for spelter so long expected has been delayed. In spite of this, however, values have on the whole been fairly well maintained in the United States. In this country prices have gradually declined, but at the lower level now established there has been considerable improvement in the interest shown by consumers, and a favourable feature is that forward spelter is now quoted at a premium, whereas at the end of March future metal stood at a discount. The Government stocks of spelter on April 1 were 27,676 tons G.O.B., or an increase of 232 tons against March 1; refined 10,371 tons, or an increase of 1,511 tons compared with a month earlier.

The average prices of good ordinary brands were: April 1919, £35. 18s. 3d.; March 1919, £37. 10s. 3d.; April 1918, £52; March 1918, £52.

The imports of spelter for March, 1919, were 11,533 tons, against 7,030 last year.

ZINC DUST.—Australian high-grade 88–92% is quoted at the reduced figure of £70 per ton f.o.r. Liverpool. It is understood that satisfactory quantities are now coming from Australia.

ANTIMONY.—The price of English regulus remains at £45 per ton, with only a small business passing. Foreign material has fluctuated slightly, but latterly shows a firmer tone at about £40 in warehouse.

ARSENIC.—The market has been quiet, and the present price is about £35 delivered London for white.

BISMUTH remains at 12s. 6d. nominal per lb

CADMIUM.—6s. 9d. to 7s. per lb.

ALUMINIUM.—£150 per ton for home business.

NICKEL.—£195 per ton for home trade.

COBALT METAL.—12s. 6d. to 13s. per lb.

COBALT OXIDE.—7s. 9d. per lb.

PLATINUM.—360s. to 440s. per oz.

PALLADIUM.—500s. per oz. nominal.

QUICKSILVER.—£16 to £17 per flask.

SELENIUM.—12s. to 15s. per lb.

TELLURIUM.—95s. to 100s. per oz.

SULPHATE OF COPPER—About £48 f.o.b. for export, and for home trade about £45.

MANGANESE ORE.—Indian about 2s. 3d. per unit c.i.f.

WOLFRAM ORE.—Wolframite 65% is quoted at 30s. per unit, and scheelite at 40s. per unit.

MOLYBDENITE is nominal.

SILVER.—On May 5 the American Government released silver from control, but the British Government did not do so until three days later. Owing to the large demand, the price has already risen considerably above the recent official maximum.

CORUNDUM.—90% is quoted at £18 c.i.f. per ton.

GRAPHITE.—80% £45 c.i.f. U.K. per ton.

IRON & STEEL.—The event of chief interest in these markets has been the relaxation from control at the end of April, and the cessation of subsidies. This has entailed the making of new prices for pig iron, and these of necessity show advances to compensate for the lack of the subsidy. In spite of these advances, however, a very good trade has been moving for delivery over the next month or two. Steel and manufactured iron prices have had to follow suit, not only to meet the increased cost of pig iron, but to recompense makers for other enlarged expenses. Business in shipyard material has been very active, but the demand for constructional work has not been so important. The price of No. 3 Cleveland G.M.B. No. 4 foundry and No. 4 forge will be increased from 95s. to 140s. as from May 1, but the latter figure will also rule for export as well as for home business. For East Coast hematite the new price will be 172s. 6d. for home and export. These, however, are minimum prices, and business is already reported at 5s. more. For steel for the home trade, it might be mentioned that ship, bridge, and tank plates will be £17, angles and joists £16. 10s. in 4-ton lots; rounds and squares under 3 in. to ⅝ in. £19; flats 5 in. to 1½ in. £19, in 4-ton lots; heavy steel rails 60 lb. and up £15 net on trucks.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
January 1918	[illegible]	19,991	714,182	3,033,653
February	[illegible]	22,188	659,759	2,802,477
March	[illegible]	19,273	696,281	2,957,614
April	697,733	19,366	717,099	3,046,045
May	720,539	20,778	741,317	3,148,915
June	708,908	[illegible]	727,696	3,091,058
July	[illegible]	20,189	736,199	3,127,174
August	719,849	20,361	740,210	3,144,211
September	686,963	21,243	708,206	[illegible]
October	667,955	[illegible]	679,764	2,887,455
November	[illegible]	17,904	658,701	2,797,983
December	[illegible]	10,740	641,245	2,723,836
Year 1918	8,197,959	221,734	8,419,693	35,768,688
January 1919	662,205	13,854	676,059	2,871,718
February	621,188	15,540	636,728	2,704,647
March	694,825	17,554	712,379	3,025,992

Natives Employed in the Transvaal Mines

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1918	176,424	11,469	4,715	192,608
February 28	181,066	11,243	4,825	197,134
March 31	183,055	11,076	4,745	198,876
April 30	182,492	11,322	4,753	198,567
May 31	179,879	11,211	4,773	195,863
June 30	179,028	11,473	4,747	[illegible]
July 31	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September 30	179,399	12,108	4,889	196,395
October 31	173,153	11,824	4,749	189,726
November 30	160,275	11,826	4,016	176,117
December 31	152,606	11,851	3,180	167,637
January 31, 1919	[illegible]	11,848	3,539	175,986
February 28	172,359	11,868	4,264	188,491
March 31	175,620	11,168	5,080	191,868

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d	s. d	s. d	£
January, 1918	2,167,411	27 1	20 7	6 4	703,665
February	1,946,338	27 5	21 7	5 11	577,396
March	2,107,561	27 1	21 4	5 8	596,109
April	[illegible]	27 0	20 8	6 2	670,871
May	2,237,644	27 3	20 6	6 5	716,963
June	2,124,205	[illegible] 2	21 0	6 11	736,694
July	2,167,869	[illegible] 10	21 2	6 6	702,360
August	2,158,431	[illegible] 1	21 7	6 [illegible]	676,146
September	2,060,635	[illegible] 2	22 0	5 10	600,330
October	2,015,144	[illegible]	22 5	5 3	531,774
November	1,899,925	[illegible]	23 1	5 1	480,102
December	1,855,091	[illegible]	[illegible] 0	[illegible] 6	507,860
Year 1918	24,922,763	[illegible] 11	[illegible]	6 0	7,678,129
January, 1919	[illegible]	[illegible] 9	[illegible] 0	5 5	[illegible]
February	[illegible]	[illegible] 9	[illegible]	[illegible]	[illegible]

Production of Gold in Rhodesia and West Africa.

	Rhodesia 1918	Rhodesia 1919	West Africa 1918	West Africa 1919
	£	£	£	£
January	—	211,917	107,863	104,063
February	232,023	220,885	112,865	112,616
March	230,023	225,808	112,605	112,543
April	239,916	—	[illegible]	—
May	239,205	—	126,290	—
June	225,447	—	[illegible]	—
July	251,740	—	[illegible]	—
August	257,096	—	[illegible]	—
September	247,885	—	[illegible]	—
October	136,780	—	[illegible]	—
November	145,460	—	[illegible]	—
December	192,870	—	[illegible]	—
Total	2,652,250	[illegible]	[illegible]	[illegible]

Transvaal Gold Outputs

	March 1919 Treated	Value
	Tons	£
Aurora West	15,000	15,316
Bantjes	—	—
Barrett	—	1,148
Brakpan	51,500	[illegible]
City & Suburban	16,157	25,089
City Deep	50,000	98,816
Cons. Langlaagte	47,200	56,072
Cons. Main Reef	50,140	73,897
Crown Mines	160,000	219,652
Durban Roodepoort Deep	27,700	40,310
East Rand P.M.	112,000	148,275
Ferreira Deep	37,000	57,611
Geduld	43,500	62,025
Geldenhuis Deep	53,100	60,657
Ginsberg	10,230	11,968
Glynn's Lydenburg	3,770	5,717
Goch	15,500	12,245
Government G.M. Areas	114,000	199,545
Heriot	11,190	16,618
Jupiter	24,400	[illegible]
Kleinfontein	66,000	76,750
Knights Central	19,100	25,327
Knights Deep	88,200	75,167
Langlaagte Estate	42,000	55,132
Luipaard's Vlei	21,000	1,110*
Meyer & Charlton	14,000	38,695
Modderfontein	88,000	183,417
Modderfontein B	54,000	123,672
Modderfontein Deep	42,800	88,799
New Unified	13,700	12,318
Nourse	40,600	57,172
Primrose	18,000	16,504
Princess Estate	21,500	27,396
Randfontein Central	143,000	166,437
Robinson	40,000	43,193
Robinson Deep	44,200	58,904
Roodepoort United	25,100	21,709
Rose Deep	54,000	59,774
Simmer & Jack	44,700	48,674
Simmer Deep	40,600	41,097
Springs	37,350	70,738
Sub Nigel	9,400	24,668
Transvaal G.M. Estates	15,910	25,012
Van Ryn	34,000	33,110
Van Ryn Deep	50,000	105,632
Village Deep	54,000	68,322
Village Main Reef	18,700	24,094
West Rand Consolidated	32,800	37,236
Witwatersrand (Knights)	35,100	39,378
Witwatersrand Deep	32,700	37,346
Wolhuter	28,700	35,180

* Loss

West African Gold Outputs

	March, 1919 Treated	Value
	Tons	£
Abbontiakoon	8,140	15,705
Abosso	7,400	12,643
Ashanti Goldfields	7,739	38,193
Prestea Block A	16,970	26,704
[illegible]	5,231	14,601
[illegible]	2,879	4,324

Rhodesian Gold Outputs

	March, 1919 Treated	Value
	Tons	£
Antelope	—	—
Cam & Motor	—	—
Eldorado Banket	—	—
Falcon	14,280	27,719*
Gaika	3,005	5,447
Globe & Phœnix	5,833	8,783†
Lonely Reef	5,000	25,587
Rezende	5,300	14,137‡
Rhodesia, Ltd.	[illegible]	3,353
Shamva	52,206	34,803
Transvaal & Rhodesian	1,800	5,750
Wanderer	[illegible]	[illegible]

* Gold, Silver, and Copper. † Ounces Gold. ‡ Gold & Silver.

West Australian Gold Statistics.

	Reported for Export oz	Delivered to Mint oz.	Total oz	Total value £
January, 1918	*	73,703	*	*
February	*	76,987	*	*
March	*	69 730	*	*
April	*	66,079	*	*
May	*	73,701	*	*
June	*	74,904	*	*
July	*	72,081	*	*
August	*	76,156	*	*
September	*	74,057	*	*
October	*	71,439	*	*
November	1,444	70,711	72,155	305,494
December	2 739	61,314	64,053	272,208
January, 1919	*	69,954	*	*
February	733	66,310	67,043	284,779
March	nil	65,158	66,158	281,120
April	33	63,465	63,498	269,720

* By direction of the Federal Government the export figures from July, 1916 to November, 1918, were not published.

Australian Gold Returns.

	Victoria		Queensland.		New South Wales	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	65,412	—	48,020	48,000	30,000	16,000
April	26,849	—	47,600	—	30,000	—
May	87,885	—	46,740	—	45,000	—
June	45,765	—	51,420		32,000	—
July	64,347	—	51,000	—	25,000	—
August	61,163	—	44,600	—	21,000	—
September	65,751	—	45,900	—	32,000	—
October	*		54,400	—	40,000	—
November	*	—	38,200	—	25,000	—
December	70,674	—	56,281	—	38,000	—
Total	674,655	83,193	578,213	128,430	370,000	58,000

* Figures not received.

Australasian Gold Outputs.

—	March, 1919 Treated Tons	Value £
Associated	6,028	8,644
Associated Northern Blocks — Iron Duke	—	2,220*
Associated Northern Blocks — Victorious	1,500	2,514
Blackwater	2,159	4 233
Bullfinch	5,069	4,863
Golden Horseshoe	12,132	23,711
Great Boulder Prop	13,025	39,165
Ivanhoe	18,016	30,720
Kalgurli	4,162	7,063
Lake View & Star	10,660	11,350
Mount Boppy	4,980	7,500
Oroya Links	1,736	12,133†
Progress	1,320	2,051
Sons of Gwalia	—	—
South Kalgurli	7,839	9,688
Talisman	—	
Waihi	15,063	24,523‡
Waihi Grand Junction	4,510	6,790§

* Surplus; † Total receipts; ‡ Gold and Silver to March 22
§ 24 days to March 22.

Miscellaneous Gold Output.

	March, 1919 Treated Tons	Value £
Barrama (Sudan)	—	740
Esperanza (Mexico)	—	—
Frontino & Bolivia (Colombia)	2,350	8,220
Nechi (Colombia)	59,056*	16,494‡
Ouro Preto (Brazil)	6,500	8,640
Pato (Colombia)	50,250*	9,377‡
Philippine Dredges (Philippine Islands)	—	724§
Plymouth Cons. (California)	11,900	12,867
St. John del Rey (Brazil)	—	36,000
Santa Gertrudis (Mexico)	36,670	26,940††
Sudan Gold Field (Sudan)	1,700	3,170

* Cubic yards. ‡ Dollars. § Ounces, fineness not stated.
†† Profit, gold and silver

Production of Gold in India

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	162,270
February	183,264	180,904	173,343	153,775
March	186,475	189,618	177,950	162,790
April	192,208	185,835	176,486	—
May	193,604	184,874	173,775	
June	192,469	182,426	174,375	—
July	191,404	179,660	171,9[illegible]	
August	192,784	181,005	172,1[illegible]5	—
September	192,330	183,630	170,36[illegible]	—
October	191,502	182,924	167,740	—
November	192,298	182,388	157,176	
December	205,164	190,852	170,630	
Total	2,305,652	2,214,163	2,061,920	480,835

Indian Gold Outputs.

	March, 1919 Tons Treated	Fine Ounces
Balaghat	2,500	2,091
Champion Reef	11,892	7,046
Hutti (Nizam's)	—	900
Jibutil	—	
Mysore	24,542	13,569
North Anantapur	1,200	912
Nundydroog	8,854	6,465
Ooregum	12,800	7,334

Base Metal Outputs

		March, 1919
Arizona Copper	Short tons copper	1,400
British Broken Hill	Tons lead concentrate	2,434
	Tons zinc concentrate	1,8[illegible]5
	Tons carbonate ore	449
Broken Hill Block 10	Tons lead concentrate	—
	Tons zinc concentrate	—
Burma Corp.	Tons refined lead	1,834
	Oz. refined silver	158,000
Cordoba Copper		101
Freemantle Trading	Long tons lead	—
North Broken Hill	Tons lead	1,469
	Oz silver	67,295
Poderosa	Tons copper ore	[illegible]
Rhodesian Broken Hill	Tons lead and zinc	1,085
Tanganyika	Long tons copper	1,482
Tolima	Tons silver-lead concentrate	40
Zinc Corp.	Tons zinc concentrate	6 440
	Tons lead concentrate	356

Imports of Ores and Metals into United Kingdom
Long tons

—	Ma[illegible]	Year 1919
	Tons	Tons
Iron Ore	[illegible]50	1,801,969
Copper Ore	2,346	7,050
„ Precipitate	2,711	5,171
„ Metal	10,475	53,730
Copper and Iron Pyrite	22,354	88,315
Tin Concentrate	4,992	15,433
„ Metal	830	4,967
Manganese Ore	36,350	131,754
Lead, Pig and Sheet	26,634	101,645
Zinc (spelter)	7,355	39,312
Zinc Oxide	239	612
Barytes	1,592	3,630
Rock Phosphate	28,493	177,875
Brimstone	–	5,103
Boracic Compounds	[illegible]	3,766
Nitrate of Potash	[illegible]	2,306
	lb.	lb
Quicksilver	380,633	918,749

United States Metal Exports and Imports

Exports.	Jan. Tons.	Feb. Tons.	Imports.	Jan. Tons.	Feb. Tons.
Copper Ingots	32,480	13,595	Antimony	1,164	511
Copper Sheets	[illegible]	1,702	Tin Ore	2,741	1,451
Copper Wire	[illegible]	2,640	Tin	[illegible]	[illegible]
Lead [illegible]	7,828	6,167	Manganese Ore	47,5[illegible]	21,819
[illegible]	6,587	9,657			
Zinc Sheets ..	1,521	4,161	Tungsten Concentrate	873	[illegible]
			Pyrites	[illegible]	1,05[illegible]

Outputs of Tin Mining Companies.

In Tons of Concentrate.

	Year 1918 Tons	Mar 1919 Tons	Year 1919 Tons
Nigeria:			
Abu	33	2	5
Anglo Continental	207	18	65
Benue	146	10	[illegible]
Bisichi [Berrida]		-	1
Bisichi	275	15	40
Bongwelli	17	5	14
Dua	60	8	[illegible]
Ex-Lands	342	30	[illegible]
Filani	37	1	5
Forum River	274	18	49
Gold Coast Consolidated	30	-	
Gurum River	99	12	34
Jantar	141	9	30
Jos	228	22	76
Kaduna	178	23	71
Kano	60	13	45
Kassa Ropp	133	-	24
Keffi	118	5	17
Kuru	12	23	59
Kaskie	21		1
Kwall	108		
Lower Bisichi	69	9	20
Lucky Chance	27	2	[illegible]
Minna	40	5	
Mongu	476	54	160
Naraguta	478	33	101
Naraguta Extended	280	15	53
New Lafon	198	21	62
Nigerian Tin	87	6	[illegible]
N. N. Bauchi	435	30	88
Offin River	120	-	16
Rayfield	689	65	197
Ropp	836	85	84
Rukuba	132	8	[illegible]
South Bukeru	94	5	15
Sybu	40	2	6
Tin Areas	96	8	[illegible]
Tin Fields	108	15	[illegible]
Toro	17	1	2
Federated Malay States:			
Chenderiang	[illegible]	52	[illegible]
Gopeng	[illegible]	[illegible]	[illegible]
Idris Hydraulic	136	20	59
Ipoh	245	15	[illegible]
Kamunting	236	96	[illegible]
Kinta	478	33	[illegible]
Kledang	28	5	
Lahat	[illegible]	18	[illegible]
Malayan Tin	730	62	[illegible]
Pahang	1,877	178	[illegible]
[illegible]	[illegible]	15	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	1	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	1,354	125	[illegible]
[illegible]	133		
[illegible]			
[illegible]	141		
[illegible]	787	[illegible]	183
East Pool	1,336	92	[illegible]
Grenville	[illegible]	52	115
South Crofty	598	51	159
Other Countries:			
Aramayo Francke (Bolivia)	1,816	[illegible]	410
[illegible] (Cornwall)	[illegible]	[illegible]	56
Deebook (Siam)	398	12	73
Mawchi (Burma)	658	[illegible]	204
Porco (Bolivia)	[illegible]	15	66
Renong (Siam)	615	94	[illegible]
[illegible] Minerals (Transvaal)	335	[illegible]	110
Siamese Tin (Siam)	[illegible]	53	[illegible]
Tongkah Harbour (Siam)	1,528	[illegible]	[illegible]
Zaaiplaats (Transvaal)	[illegible]	[illegible]	[illegible]

Nigerian Tin Production

In long tons of concentrate of unspecified content.

Note. These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85% of the actual outputs.

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	608
February	469	358	528	646	668	620
March	502	418	547	655	707	582
April	482	444	486	555	584	
May	480	357	536	509	525	—
June	460	373	510	473	492	—
July	432	455	506	479	545	
August	228	438	498	551	571	—
September	289	442	535	538	520	—
October	272	511	584	578	491	—
November	283	467	679	621	472	—
December	326	533	654	655	518	—
Total	4,708	5,213	6,594	6,927	6,771	1,810

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Total, 1917	4,186	£561,003	£134 0 0
January 14, 1918	141	£23,563	£167 2 3
January 28	171½	£28,976	£168 19 2
February 11	166½	£29,674	£178 4 6
February 25	156½	£28,213	£180 18
March 11	178¼	£33,398	£187 7 4
March 25	169½	£31,253	£184 7 9
April 8	157¼	£29,575	£188 1 8
April 22	159½	£31 402	£196 17 7
May 6	172¼	£39,939	£232 4 4
May 21	169¼	£36,791	£217 1 2
June 3	172	£36,109	£209 18 9
June 18	153	£29,692	£194 1 9
July 1	170¾	£34,035	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£231 4 6
August 13	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142½	£28,793	£202 1 2
September 23	145¾	£29,639	£203 7 2
October 7	136½	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	166¾	£25,170	£150 19 0
December 16	175½	£26.032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average 1918	4,094	£786,541	£192 0 0
January 13, 1919	160	£20,838	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24	142	£15,015	£105 14 10
March 10	144½	£18,123	£125 8 5
March 24	148½	£17 877	£120 7 8
April 7	134½	£15,258	£111 8 10
April 22	134¼	£15,023	£111 18 1

Details of Redruth Tin Ticketings

	April 7 Tons Sold	April 7 Realized per ton £ s d	April 22 Tons Sold	April 22 Realized per ton £ s. d.
E. Pool & Agar, No. 1	10	111 7 6	10	110 10 0
„ No. 1a	10	109 15 0	10	109 10 0
„ No 1b	10	109 0 0	10	109 15 0
„ No. 1c	10	109 5 0	10	108 10 0
Dolcoath, No. [illegible]	7	118 7 6	10	118 0 0
[illegible]	7	115 15 0	10	118 15 0
[illegible]	8	116 0 0	—	—
[illegible]	13	60 7 6	3	60 15 0
[illegible]	13	107 15 0	2	107 7 6
South Crofty, No. 1	10	116 7 6	10	116 15 0
„ No 1a	11	115 10 0	11	115 5 0
Grenville Utd., No 1	8	115 0 0	8	110 5 0
„ „ No 1a	8	114 10 0	7	110 5 0
„ „ No. [illegible]			3	56 7 6
Tincroft Mines, No. 1	7	120 15 0	7	119 5 0
„ No. 1a	8	119 15 0	7	120 0 0
Levant Mines	13	118 15 0	13	121 0 0
Wheal Bellan		—	1¼	115 10 0
Hingston Downs	½	123 0 0	—	—
Botallack Bottoms	—	—	2	102 10 0
Total	134½		134¼	

PRODUCTION OF TIN IN FEDERATED MALAY STATES.

Estimated at 70% of Concentrate shipped to Smelters. Long Tons. * Figures not published.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January	4,395	4,316	3,558	3,149	3,765
February	3,780	3,372	2,755	3,191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	
May	3,823	3,729	3,413	3,332	—
June	4,048	3,435	3,489	2,950	—
July	3,544	3,517	3,253	3,373	—
August	4,046	3,732	3,413	3,259	—
September	3,932	3,636	3,154	3,166	
October	3,797	3,681	3,436	2,870	—
November	4,059	3,635	3,300	3,131	
December	4,071	3,945	3,525	3,023	—
	46,767	43,871	39,833	37,370	9,257

STOCKS OF TIN

Reported by A. Strauss & Co. Long Tons.

	March 31 1919	April 30, 1919
	Tons	Tons
Straits and Australian Spot	1,063	1,458
Ditto, Landing and in Transit	1,949	689
Other Standard, Spot and Landing	604	719
Straits, Afloat	1,230	1,682
Australian, Afloat	405	335
Banca, on Warrants	—	—
Ditto, Afloat	—	—
Billiton, Spot	—	-
Billiton, Afloat	—	—
Straits, Spot in Holland and Hamburg	—	—
Ditto, Afloat to Continent	1,024	110
Total Afloat for United States		—
Stock in America	156	1,0
Total	6,431	5,113

SHIPMENTS, IMPORTS, SUPPLY AND CONSUMPTION OF TIN.

Reported by A. Strauss & Co. Long tons.

	March 1919	April 1919
	Tons	Tons
Shipments from		
Straits to U.K.	1,230	1,117
Straits to America	-	
Straits to Continent	1,024	110
Australia to U.K.	300	200
U.K. to America		—
Imports of Bolivian Tin into Europe	—	2,681
Supply:		
Straits	2,254	1,227
Australian	300	100
Billiton	—	—
Banca	732	—
Standard	409	494
Consumption:		
U.K. Deliveries	1,448	2,07
Dutch ,,	45	39
American ,,	2,070	36
Straits, Banca & Billiton, Continental Ports, etc.	618	1,717
Straits in hands of Malay Government	—	6,000 to 7,000
,, controlled by U.S. Government	—	1,000 to 1,500
,, ,, ,, French and Italian Governments	—	1,000
Banca and Billiton controlled by Dutch Government	—	3,000 to 4,000

PRICES OF CHEMICALS May 10

		£	s.	d
Alum	per ton	17	0	0
Alumina, Sulphate of	,,	19	0	0
Ammonia, Anhydrous	per lb.		1	10
,, 0·880 solution	per ton	32	0	0
,, Carbonate	per lb.			6½
,, Chloride of, grey	per ton	50	0	0
,, ,, ,, pure	per cwt.	4	0	0
,, Nitrate of	per ton	70	0	0
,, Phosphate of	,,	115	0	0
,, Sulphate of	,,	17	10	0
Antimony Sulphide	per lb.		1	3
Arsenic, White	per ton	34	0	0
Barium Sulphate	,,	12	0	0
Bisulphide of Carbon	,,	52	0	0
Bleaching Powder, 35% Cl.	,,	15	0	0
Borax	,,	39	0	0
Copper, Sulphate of	,,	47	0	0
Cyanide of Sodium, 100%	per lb			10
Hydrofluoric Acid	,,			7
Iodine	,,		14	0
Iron, Sulphate of	per ton	5	10	0
Lead, Acetate of, white	,,	85	0	0
,, Nitrate of	,,	62	0	0
,, Oxide of, Litharge	,,	46	0	0
,, White	,,	52	0	0
Lime, Acetate, brown	,,	13	0	0
,, ,, grey 80%	,,	17	0	0
Magnesite, Calcined	,,	25	0	0
Magnesium Chloride	,,	16	0	0
,, Sulphate	,,	11	0	0
Methylated Spirit 64° Industrial	per gal.		6	7
Phosphoric Acid	per lb.		1	8
Potassium Bichromate	,,		2	0
,, Carbonate	per ton	90	0	0
,, Chlorate	per lb.		1	2
,, Chloride 80%	per ton	55	0	0
,, Hydrate, (Caustic) 90%	,,	250	0	0
,, Nitrate	,,	60	0	0
,, Permanganate	per lb		4	0
,, Prussiate, Yellow	,,		2	0
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	65	0	0
,, Arsenate 45%	,,	48	0	0
,, Bicarbonate	,,	9	10	0
,, Bichromate	per lb.		1	2
,, Carbonate (Soda Ash)	per ton	10	0	0
,, ,, (Crystals)	,,	4	5	0
,, Chlorate	per lb.			10
,, Hydrate, 76%	per ton	24	10	0
,, Hyposulphite	,,	16	0	0
,, Nitrate, 95%	,,	22	0	0
,, Phosphate	,,	26	10	0
,, Prussiate	per lb.			9
,, Silicate	per ton	12	0	0
,, Sulphate (Salt-cake)	,,	3	0	0
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	23	0	0
Sulphur, Roll	,,	22	10	0
,, Flowers	,,	28	10	0
Sulphuric Acid, Non-Arsenical 140°T.	,,	5	0	0
,, ,, ,, 90%	,,	7	5	3
,, ,, ,, 96%	,,	9	7	6
Superphosphate of Lime, 18%	,,	5	0	0
Tartaric Acid	per lb.		3	5
Zinc Chloride	per ton	25	0	0
Zinc Sulphate	,,	23	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	May 7, 1918 £	s.	d.	May 7, 1919 £	s.	d.
Rand						
Bantjes		3	0		5	6
Brakpan	4	15	0	3	11	[illegible]
Central Mining (£8)	5	17	6	6	17	6
Cinderella		4	0		[illegible]	[illegible]
City & Suburban (£4)		18	9		1[illegible]	[illegible]
City Deep	3	5	[illegible]	2	17	6
Consolidated Gold Fields	1	15	[illegible]	1	17	[illegible]
Consolidated Langlaagte		16	[illegible]	1	1	[illegible]
Consolidated Main Reef		15	[illegible]		15	[illegible]
Consolidated Mines Selection (10s)	1	10	6	1	7	[illegible]
Crown Mines (10s)	1	16	3	2	5	[illegible]
Daggafontein	1	8	[illegible]	1	[illegible]	[illegible]
D. Roodepoort Deep		9	[illegible]		8	[illegible]
East Rand Proprietary		4	[illegible]		5	6
Ferreira Deep		14	6		13	9
Geduld	1	19	6	2	12	[illegible]
Geldenhuis Deep		13	0		10	9
Gov't Gold Mining Areas	3	13	0	4	13	9
Heriot	1	1	3		18	[illegible]
Jupiter		5	0		4	[illegible]
Kleinfontein		17	9		15	6
Knight Central		3	0		7	0
Knight's Deep		8	0		8	[illegible]
Langlaagte Estate		13	6	1	1	6
Meyer & Charlton	4	10	3	4	11	[illegible]
Modderfontein (£4)	22	15	0	26	15	0
Modderfontein B	7	16	3	8	[illegible]	[illegible]
Modder Deep	7	5	9	7	10	0
Nourse		17	6		14	0
Rand Mines (5s.)	2	17	0	3	1	[illegible]
Rand Selection Corporation	4	15	0	4	5	0
Randfontein Central		11	6		15	0
Robinson (£5)		15	6		15	9
Robinson Deep A (1s.)	1	0	6		18	9
Rose Deep		18	3		17	[illegible]
Simmer & Jack		5	3		4	[illegible]
Simmer Deep		3	0		2	9
Springs	3	15	0	3	3	9
Sub Nigel	1	6	3	1	8	9
Van Ryn	1	1	3		16	[illegible]
Van Ryn Deep	3	10	0	3	10	[illegible]
Village Deep	1	0	0		16	[illegible]
Village Main Reef		12	0		12	[illegible]
Witwatersrand (Knight's)	1	5	0	1	3	[illegible]
Witwatersrand Deep		7	9		1[illegible]	[illegible]
Wolhuter		[illegible]	0		[illegible]	[illegible]
Other Transvaal Gold Mines						
Glynn's Lydenburg		18	9	1	2	[illegible]
Sheba (5s.)			9		1	[illegible]
Transvaal Gold Mining Estates		16	0		14	[illegible]
Diamonds in South Africa						
De Beers Deferred (£2 10s.)	12	17	6	20	5	0
Jagersfontein	4	2	6	[illegible]	[illegible]	[illegible]
Premier Deferred (2s. 6d.)	6	15	6	7	7	6
Rhodesia						
Cam & Motor		11	0		[illegible]	[illegible]
Chartered British South Africa		16	[illegible]	1	[illegible]	[illegible]
Eldorado		[illegible]	9		[illegible]	[illegible]
Falcon	1	[illegible]	[illegible]		15	6
Gaika		18	9		18	[illegible]
Giant		7	[illegible]		7	[illegible]
Globe & Phœnix (5s.)	1	11	[illegible]	1	8	9
Lonely Reef	1	1	0	2	10	[illegible]
R[illegible]	4	2	6	5	18	9
[illegible]	2	0	0		[illegible]	[illegible]
[illegible]		1	0		1	0
[illegible]		5	0		6	9
West Africa						
A[illegible]		3	[illegible]		5	0
Abosso		7	6		7	0
Ashanti [illegible]		[illegible]	[illegible]	1	5	0
Prestea [illegible]		[illegible]	[illegible]		5	0
Taquah		1	[illegible]		[illegible]	[illegible]
West Australia						
Associated Gold Mines		[illegible]	6		4	0
Associated Northern Blocks		2	[illegible]		4	0
Bullfinch		1	[illegible]		1	6
Golden Horse-Shoe (£5)	[illegible]	2	6	1	1	9
Great Boulder Proprietary (2s.)		11	6		11	6
Great Fingall (10s).		1	9		[illegible]	[illegible]
Ivanhoe (£5)	1	1[illegible]		2	[illegible]	[illegible]
Kalgurli		9	[illegible]		12	[illegible]
Sons of Gwalia		[illegible]	[illegible]		7	0

GOLD, SILVER, cont.	May 7, 1918 £	s.	d.	May 7, 1919 £	s.	d.
Others in Australasia						
Mount Boppy, New South Wales		7	6		3	9
Talisman, New Zealand		15	0		12	6
Waihi, New Zealand	1	15	0	2	2	6
Waihi Grand Junction, New Z'lnd		16	0		14	6
America						
Alaska Treadwell (£5), Alaska		10	0	1	12	6
Buena Tierra, Mexico		12	6	1	0	0
Camp Bird, Colorado		8	6	1	1	3
Casey Cobalt, Ontario		9	0		4	0
El Oro, Mexico		9	0	1	1	3
Esperanza, Mexico		8	3		14	6
Frontino & Bolivia, Colombia		12	6		12	0
Le Roi No. 2 (£5), British Columbia		7	[illegible]		8	9
Mexico Mines of El Oro, Mexico	5	16	3	7	17	6
Oroville Dredging, California		19	0	1	7	0
Plymouth Consolidated, California	1	2	6	1	6	3
St. John del Rey, Brazil		16	0		18	9
Santa Gertrudis, Mexico		13	0	1	7	0
Tomboy, Colorado		17	9		15	0
Russia						
Lena Goldfields	1	5	0	1	12	6
Orsk Priority		12	6		15	0
India						
Balaghat		4	3		4	3
Champion Reef (2s. 6d.)		5	6		4	6
Mysore (10s.)	2	12	0	2	0	0
North Anantapur		3	9		3	0
Nundydroog (10s.)	1	2	6		18	6
Ooregum (10s.)		19	6		16	0

COPPER:

	May 7, 1918 £	s.	d.	May 7, 1919 £	s.	d.
Arizona Copper (5s.), Arizona	2	7	6	2	0	0
Cape Copper (£2), Cape Province	2	15	0	2	7	6
Chillagoe (10s.), Queensland		1	0		1	9
Cordoba (5s.), Spain		2	6		1	3
Great Cobar (£5), N.S.W		2	0		1	6
Hampden Cloncurry, Queensland	1	7	[illegible]	1	0	0
Kyshtim, Russia		17	6	1	18	9
Messina (5s.), Transvaal		8	0		5	0
Mount Elliott (£5), Queensland	3	10	0	3	5	0
Mount Lyell, Tasmania	1	7	9	1	3	0
Mount Morgan, Queensland	1	12	0	1	4	6
Namaqua (£2), Cape Province	1	17	6	1	15	0
Rio Tinto (£5), Spain	66	10	0	55	10	0
Sissert, Russia		15	0	1	15	0
Spassky, Russia		17	6	1	15	0
Tanalyk, Russia		17	6	2	5	0
Tanganyika, Congo and Rhodesia	3	3	0	4	5	0
Tharsis (£2), Spain	6	12	6	5	15	0

LEAD-ZINC:

	May 7, 1918 £	s.	d.	May 7, 1919 £	s.	d.
Broken Hill						
Amalgamated Zinc	1	7	9	1	3	0
British Broken Hill	2	5	9	2	8	9
Broken Hill Proprietary (8s.)	3	8	0	2	5	3
Broken Hill Block 10 (£10)	1	15	0	1	7	0
Broken Hill North	3	1	3	2	13	0
Broken Hill South	10	10	0	2	10	0*
Sulphide Corporation (15s.)	1	7	0	1	4	9
Zinc Corporation (10s.)	1	3	0	1	4	0
Asia						
Burma Corporation	4	6	3	6	15	0
Irtysh Corporation		18	9	2	3	0
[illegible]		7	6	1	0	0
[illegible]	2	1	3	4	12	6

TIN:

	May 7, 1918 £	s.	d.	May 7, 1919 £	s.	d.
Aramayo Francke, Bolivia	2	8	9	3	8	9
Bisichi, Nigeria		15	3		15	9
Briseis, Tasmania		6	0		5	3
Dolcoath, Cornwall		12	9		8	0
East Pool, Cornwall	1	11	3	1	2	0
Ex-Lands Nigeria (2s.), Nigeria		2	9		2	6
Geevor, Cornwall	1	6	3		14	6
Gopeng, Malay	1	16	3	2	3	9
Ipoh Dredging, Malay		17	0	1	2	6
Malayan Tin Dredging, Malay	2	1	3	2	12	6
Mongu (10s.), Nigeria		16	3		18	6
Naraguta, Nigeria		17	6		18	0
N. N. Bauchi Pref. (10s.), Nigeria		12	6		12	3
Ord. (10s.)		12	6		7	6
Pahang Consolidated (5s.), Malay.		12	9		17	0
Rayfield, Nigeria		14	[illegible]		15	0
Renong Dredging, Siam	2	5	0	2	6	3
Ropp (4s.), Nigeria	1	4	[illegible]	1	5	3
Siamese Tin, Siam	3	[illegible]	[illegible]	3	7	6
South Crofty (5s.), Cornwall	2	10	6	1	15	0
Tekka, Malay	3	15	0	4	5	0
Tekka-Taiping, Malay	3	15	0	4	5	0
Tronoh, Malay	1	13	0	[illegible]	[illegible]	6

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

CIRCULAR VERSUS RECTANGULAR SHAFTS.

In the April issue we quoted Mr. W. L. White's description of the "square" shaft adopted at Randfontein and New State Areas. Herewith we quote Mr. C. E. Knecht's arguments in favour of long rectangular or seven-compartment shafts and Mr. H. Stuart Martin's reasons for adopting the circular shaft. These three papers were read at the January meeting of the South African Institution of Engineers.

Seven-Compartment Shafts.—Mr. C. E. Knecht said that in the Far East Rand, especially east of the Brakpan-Government Areas section, the conditions which are in the main responsible for sinking difficulties, are, firstly, the existence at a comparatively shallow depth of dolomite beds carrying considerable quantities of water, and secondly, the occurrence in the upper horizon of the Dolomite Series of an igneous sheet locally called the "Rotten" or "Green" dyke. The latter usually is about 80 ft. in thickness and disintegrates upon exposure to air, swells, and develops considerable pressure. These characteristics are especially marked in the lower half of the dyke where the ground to be sunk through gives trouble.

The considerations which are deemed of most importance in their bearing upon the relative merits of the three types of shaft are: (1) during the process of sinking: (*a*) safety in sinking, (*b*) normal rate of sinking, (*c*) ability to cope with water and other sinking difficulties; and (2) for the completed shaft: (*a*) ventilation area, (*b*) hoisting capacity for ore, men, and materials, (*c*) original and maintenance cost.

Dealing firstly with safety, vertical shaft sinking, no matter what the type of shaft, is a dangerous undertaking at best, and unfortunately is sometimes accompanied by loss of life or serious injury. The most common type of accident in shaft sinking is that caused by falling rock and material; the circular shaft is the least subject to such accidents, on account of the protection afforded the sinking gang by the Galloway stage. Seven-compartment and "square" shafts are sunk without a platform, this being obviously impracticable, so accidents of the kind mentioned therefore are more liable to occur. After a fair depth has been attained in the seven-compartment shaft, experience has shown that falling rock rarely reaches the bottom owing to its lodgment in the timbers in its fall. In the course of sinking at Brakpan the whole contents of the sinking bucket has often been spilled in the shaft, but very few pieces of rock reached the bottom. Further, the brattice being approximately in the centre of the shaft, falls are confined to one half of the shaft, and the gang at the bottom can locate them by the noise created and a rush for the other end of the shaft takes place. This also is what would occur if the bucket or skip itself comes down through the breaking of the winding rope or other cause. The seven-compartment shaft is less liable to accidents of the kind referred to than the square type owing to the longer excavation, 46 ft., as against 29 ft., allowing of more room for escape when warning is given.

A factor of prime importance in mining is that as little delay as possible should occur in reaching the reef, developing the property, and arriving at the productive stage. The type of shaft, therefore, which reduces to a minimum the risk of either greatly retarded speed in sinking or periodic cessation of sinking operations owing to water or other difficulties, is the type which commands the merits desired. It is difficult to say definitely which type of shaft, under favourable conditions, can be sunk the most rapidly. Theoretically, the circular and square types have some advantage on account of better facilities for cleaning out after the blast. It is true a less number of holes have to be drilled per round in the circular and square type, but this factor bears more upon costs than upon the actual speed of sinking. Less timber is required in the square shaft, but here again, the effect is upon costs only, as timbering is not the determining factor affecting the rate of sinking. It may be said that for all practical purposes, the normal rate of sinking of the three types of shafts under discussion is much the same, or, if any advantage may in practice be placed to the credit of the circular or square types, it is not great and may be regarded as of minor importance.

Of the difficulties to be overcome in shaft-sinking in the Far East Rand, water is the most serious, retarding the speed of sinking, and sometimes causing temporary cessation of progress. It has been found by experience that the most effective way to deal with the water is by baling. This method is impracticable except to a limited extent in sinking a circular shaft. Pumping must be resorted to, which must be carried out under the most difficult conditions of varying and excessive heads. Circular shafts handling water by pumps only have often been sunk in Europe and America, but, under South African conditions, the difficulties in obtaining plant on short notice, and the constant delays and temporary stoppages are such as very seriously to delay progress. It is the experience on the Rand, that even a moderate quantity of water becomes an obstacle affecting the speed of sinking in a circular shaft, and that the sealing of the water-bearing fissures by cementation becomes advisable.

The author proceeded to give an outline of the cycle of operations in sinking a seven-compartment shaft through water-bearing strata, the quantity of water being up to a maximum of, say, 100,000 gallons per hour. The hoisting equipment provides for three winders; two of them temporary geared hoists, and a direct-acting winder, which is erected to serve compartments 5 and 6 and is part of the permanent equipment. The geared hoists serve compartments 1B and 2, and 3 and 4. No. 1 compartment has the dimensions 9 ft by 6 ft. 6in., and is divided into two portions, A and B, by a temporary divider during the sinking period. Compartments 1 A and 7 are reserved for sinking pumps. The latter sit on the bottom set of timbers and work under a head which is never more than 40 ft. Starting with the shaft after it has been un-watered after the blast, the water entering the shaft bottom is lifted to the baling ring by the two pumps. The water is baled to the surface from the ring by the balers working in Nos. 1B, 2, 5 and 6 compartments. The shaft is cleaned out with the engine in Nos. 3 and 4 compartments, and is then drilled over. While this is being done the timbermen do any blocking necessary, or hang in another set of timber. The holes being finished, they are charged up, and the fuses are tied to the bottom set of timber, or to a special temporary frame under the bottom set. The suctions of the two pumps are then lifted, and the baling boys at the ring proceed to the surface on the balers. The holes are then lit up, and the sinkers hauled up the shaft about three hundred feet. When the shots have gone off, and have been counted, they go to the surface. The next shift of men then goes down to the bottom set and makes the necessary examination to see that the balers run free. When everything is clear the balers are rung down to the bottom, and continue dipping into the bottom until the tanks are no longer full. While dipping is proceeding the pumps are examined and overhauled; the engines are then clutched to the baling ring, and the pumps started, to remove the remaining water at the bottom. The essential points which must be carefully watched to ensure the continuity of the cycle are: All shots must have gone off before the water rises to the level of the bottom set of timbers, otherwise the bottom set is pulled out even when properly blocked. No damage should be done to the timbers or guides, so that the balers can be started baling from the bottom as soon as possible after the blast, to reduce to a minimum the accumulated water. The pumps must be thoroughly overhauled during the interval when the baling tanks are dripping from the bottom, as their efficiency rapidly deteriorates when operating under full load on the gritty water which must be handled. The balers must be capable of dipping into the bottom at short notice in case of any breakdown of the pumps. It would seem to the author that practically the same method of dealing with large quantities of water as described may equally be applied in sinking the square type of shaft. The hoisting facilities for balers may be arranged for a similar baling capacity, and sufficient area would remain to allow of ample room for the necessary pumps. The balers would be capable of dipping from the bottom after the blast, as in the seven-compartment type. The conclusion to be drawn, therefore, is that of the three types the square and seven-compartment shafts have distinct advantages, at least in South Africa, over the circular type, in sinking through water-bearing strata such as are prevalent in the Far East Rand. In the square type, however, the engine for cleaning out operates in compartments also used by the baler, which constitutes a distinct disadvantage, as an accident either to the skip or baler would very likely affect both. Further, the two sets of balers working in such close proximity to each other are liable to foul one another while dipping from the bottom.

Having briefly discussed the various points in connection with sinking, the author proceeded to consider the three types from the standpoint of the completed shaft. This involves the consideration of the work the shaft will be required to perform which, in turn, depends upon the mining conditions, probable tonnage capacity of the mine, ventilation requirements, and requirements as to handling of men and material. For ventilation purposes, it is self-evident that for equal areas of excavation the circular shaft is considerably more efficient than either the square or seven-compartment type. Comparing the latter two types, the square type, of the dimensions adopted by the New State Areas, is to be preferred. The ratio of area to periphery of the seven-compartment type is 3·4 to 1, which compares with 4·4 to 1 for the square type. The percentage of the shaft area obstructed by timbers is 28·6% in the seven-compartment, as against 24·5 in the square shaft. The unobstructed areas are 257 sq. ft. and 267 sq. ft. respectively. Although by comparison the seven-compartment shaft is the least favourable design of the three types for ventilation purposes, its capacity in this respect has, in practice, been found quite sufficient for all requirements.

There are two conditions in the Far East Rand which have an essential bearing upon the type of shaft best suited to efficiently deal with them. In the first place, the tonnage-producing capabilities in the more favourably situated portions of the district, though varying considerably, are large. When the mining venture presumes mining from a depth of 4,000 ft. and over, as in portions of the Far East Rand, a large tonnage production is, moreover, essential, otherwise the venture loses its attractiveness unless the yield is much higher than can reasonably be looked for in that district. The design of the shaft must, therefore, allow of flexibility as to hoisting capacity and must not be limited from the start to too narrow limits in this regard.

The second characteristic of the district is, that the payable ore occurs in shoots or elongated lenses, more or less trending in one direction and parallel to one another. Considerable stretches of barren or unpayable ore separate the payable bodies; on an average these aggregate probably 60% of the area. Including cross-cut rock, etc., therefore, probably between 60 and 70% of the development rock produced is unpayable. This rock must be kept out of the ore bins as far as possible, and hoisting facilities must be provided so that it may be dealt with separately and dumped.

The hoisting facilities of circular and square shafts are the same. They are both committed from the start to only two winders before the actual conditions in the mine they are to serve are known. One serves cages for men and material, and the other is for winding ore. The seven-compartment shaft has six winding compartments, and can be equipped with three winders, namely, one to serve cages, one for the regular hoisting of ore, and a third of smaller dimensions which is also part of the sinking equipment, to deal separately with waste and unpayable development rock, besides being a very useful spare to tide over any breakdown of the regular rock hoist. The importance of the additional winder will at once be apparent when it is remembered that in a large mine of, say, a capacity of 100,000 tons milled per month, the development and cross-cut rock produced would total, say, about 15,000 tons per month, of which on an average, say, 10,000 tons is likely to be unpayable. The inclusion of the latter with the ore sent to the mill not only involves a direct loss in treatment, but prevents the full use of the reduction plant upon ore yielding a profit, the monthly profits of the mine being thereby very materially reduced.

It may be argued that with two winders arrangements can be made for changing the cages for skips during a part of the day for the purpose of hoisting waste, or that the hoisting capacity for ore installed may be made sufficient to deal with the extra waste. This can be done, but it is found in practice in a large mine that the cages are generally fully occupied, and that the change to skips is cumbersome and involves loss of time.

The hoisting of waste by the ore hoist is also inconvenient and involves special arrangements in the headgear. Where considerable foot-wall cross-cutting is being done, the total tonnage of waste to be hoisted separately is large, and the capacity of the waste bin is soon reached during the period when ore is being hoisted, with the inevitable result that the waste is dumped into the ore bin. The rate of tramming waste is not regular, and often is concentrated during certain periods when it is not convenient to stop winding ore in order to deal with it. The larger capacity of the skips also involves a larger winder and larger ropes, which adds to the equipment cost, especially when hoisting from great depths.

The matter of economically handling long jumpers and mine poles is provided for in all three types of shaft, in the circular and square types by the large size of the cage compartments, in the seven-compartment shaft it is attained by provision of one large compartment at the end. A double-deck 9 ft. cage, which runs in balance with a three-deck cage in the adjoining 5 ft. compartment, is the equipment installed.

There is a further important matter in connection with the installation of a third winder in the seven-compartment type of shaft. Experience has shown that, with a good modern plant, winding engine and shaft breakdowns are not of very frequent occurrence and that consequently reasonably good continuity of operations can be looked for. On the other hand, owing to the scale of operations and the very large number of men required to be handled, the loss entailed by possible stoppages due to winding plant breakdowns is correspondingly large. The third winder, which normally handles waste rock and a certain quantity of material, can be made available in case of emergency for handling either ore or men, and the saving, through the avoidance of short stoppages of operations over the life of the mine, is considerable.

The general factor of safety of the square type of shaft, as regards skip and cage derailments and other winding accidents, as far as the strength of guides and dividers is concerned, does not differ materially from that of the seven-compartment shaft, but in the event of a serious accident of this kind the effect of the damage likely to be done to the shaft would be much greater in the square type than the seven-compartment. For example, in the event of a number of centre dividers being torn out in the square shaft, all normal shaft operations would have to cease owing to the dividers being common to the two sets of winding compartments. The probability of a total cessation of operations in the seven-compartment type is considerably less, and repair work would be easier and more quickly done.

Further, when a rope accident occurs, the long length of loose rope coils itself throughout the adjoining compartments in its fall. In the square or circular type of shaft, it is quite possible that such an accident might cause obstruction in all the compartments, totally preventing winding operations and rendering it very difficult to remove the broken rope and repair the shaft. Should the accident occur while men were being hoisted or lowered, the full cage would have to be instantly stopped in the shaft and, with the compartments obstructed, it would be a very difficult task to rescue the men from their precarious position. In the seven-compartment shaft equipped with three engines, this position could not arise, as, owing to the length of the shaft, at least one engine would be available to allow of the men being reached and to effect repairs to the shaft.

A feature of considerable importance also is the location of the water and air columns, power and signalling cables. In the square shaft this is in the rock-winding compartments; the obvious disadvantages pertaining to this feature are the great risks of damage in the event of winding accidents, and also the difficulty of installing and repairing these columns and cables without interfering with normal rock-winding operations.

In the matter of original cost of shaft sinking, it may be stated at the outset that this is probably in favour of the circular and square types. Maintenance costs are in favour of the circular shaft. Comparing the two timbered shafts, no great difference would be expected for ordinary maintenance, but in case of serious accident the cost of repairs would probably be less for the seven-compartment type.

Although the sinking cost of the seven compartment shaft is greater than that of the square and circular types, possibly as much as £30,000 greater for a depth of 4,000 ft., the added facilities afforded by the seven-compartment shaft when completed, especially the advantages which the installation of a third winder confers over the whole life of the mine, are such as to more than compensate for the greater expenditure in sinking.

Circular Shafts.—Mr. H. Stuart Martin said that the chief factor which goes toward deciding the type of shaft is the minimum cost that will meet the requirements of a particular problem. Therefore no engineer can advocate any one type of shaft under all conditions as being preferable to all other types; although, in the writer's opinion, the circular shaft can be made to meet nearly all conditions, and carries with it the greater number of advantages over any other type.

If the strata to be sunk through consist of weak beds of shale (such as is often met with in Carboniferous measures) or junction beds consisting of clays, sand, and water, the strongest form of shaft is necessary to make the shaft walls permanently secure. The strongest method of securing shaft walls in weak ground is the arched or circular wall with mass concrete walling or bricking. Under these conditions, the circular shaft has the advantage.

The advantage in sinking a circular shaft in strong ground is in costs, roughly 50% less powder being required and, as a rule, faster sinking.

In a circular shaft, blasting is much simplified as compared with a rectangular shaft, for the following reasons: The minimum distance of excavation between the sides of an ordinary circular shaft is greater than that of a rectangular shaft designed for the same duty. A good round of sumping shots can, therefore, be blasted, leaving a regular, circular bench of ground to be subsequently blasted by a round of side holes placed in selected positions. Such side blasting holes, if discreetly placed, have the effect of securing a circular form of excavation to the required dimensions, without the necessity of any subsequent dressing off by hand or other means, thus breaking the minimum of waste ground, particularly so in faulty and jointed ground. In the case of a rectangular shaft, particular care must be taken during blasting operations to ensure the shaft being excavated to its full dimensions for the reception afterward of the shaft timbers; and in variable ground, when a complete series of holes are fired consecutively across the shaft bottom in one operation, it is not always possible to guarantee the desired result. Unless successful blasting is obtained to give full clearance to required dimensions, a second operation of dressing is required, and more particularly at the corners of the shaft. There is, therefore, a tendency toward excavating more ground than absolutely necessary in order to ensure sufficient clearance being produced by the first operation of blasting. Irregularity in excavation of a rectangular shaft implies additional cost in the fixing of shaft timbers.

The circular shaft lends itself to an easier method of temporary support than a rectangular shaft by the use of steel rings and cribbing close up to the blast. This is important in weak ground, and any bad ground can subsequently be completely lined by brick walling or mass concrete walling, making a very secure job which requires no further attention. In the same manner, ordinary feeders of water can be kept back by the use of water-tight walling. The difficulties caused by such feeders, which are a constant source of trouble in the rectangular shaft, are done away with in a round shaft.

A circular shaft, 20 ft. in the clear, is sunk at about 21 ft. 6 in. diameter in the hands of a skilful master-sinker. The quantity of explosives used averages about 15 lb. (including primer cartridges) per foot sunk, when sinking in quartzite. The circular shaft can be sunk with a minimum of 1½ in. to 2 in. waste rock broken; the usual thickness of walling is 6 in. to 9 in., allowing 1½ in. to 2 in. behind the walling for grouting. A shaft sunk in this neat fashion is a great aid to rapid walling; from 60 to 80 ft. of walling per 24 hours (3 shifts) is considered rapid walling. If a shaft is sunk through water-bearing measures, and is rectangular, the obstructions which exist in the form of shaft framing, etc., call for constant examination and attention, and create a wet condition to the shaft which imposes a considerable charge in upkeep and winding equipment; whereas if the shaft is circular it may be suitably lined, is practically free from obstructions, and can be kept dry. A dry downcast shaft, particularly when mining at great depth, is most desirable.

The modern practice in circular shafts of employing a system of lining, consisting either of cast iron, brickwork, or concrete, has, in addition to the factor of ground support, the great advantage of producing a perfectly smooth surface to ventilation. Suitable lining may also be introduced into a rectangular shaft, but even under the best of conditions the same ventilation efficiency, area for area, as compared with the circular shaft, cannot be obtained on account of the difference in form of the air passage and of the creation of eddy currents.

As regards the question of comparative cost of lining a circular shaft and a rectangular shaft with similar material and effecting the same resistance (strength is of importance in deciding upon the type of shaft to be sunk), area for area, the cost of lining a circular shaft will be 30 to 40% less than that of a rectangular shaft with the same thickness of lining. In addition to this fact, the rectangular shaft will require a thicker and stronger lining than a circular shaft to give the same degree of safety, thereby further increasing the cost.

A comparison may be made between a rectangular shaft completely equipped with frame timbers, lagging, and guides, and a circular shaft, of size suitable to meet the same duty, completely lined with an ordinary concrete or brickwork lining. In such a parallel case the cost of the provision and fixture of timber framing and guides for the rectangular shaft would exceed the cost of the circular shaft lining and conductor equipment by an amount of possibly 30%.

The Galloway stage in circular shafts provides for the maximum safety of the sinkers, by providing a cover protecting the workers at the shaft bottom. On the score of safety, there is no comparison with this stage during sinking operations. It is used as a walling platform, and for putting in pipes, cables, byats, etc., much of which latter work is done during sinking operations without danger to the sinkers. Actual walling is not done during sinking.

It is interesting to note that in Scotland, where the type of shaft employed has in the past always been rectangular, recent shafts, sunk to depths of approximately 2,000 ft., have been made circular in form. One advantage gained is greater facility for closing off water through the water-bearing measures. All such water encountered when sinking the older form of rectangular shafts has remained as a permanent pumping charge for the life of the mine. If the quantity of water encountered does not justify the employment of pumps, it being possible to keep the shaft drained by bailing, there is practically no difference in the type of shaft selected, whether circular or rectangular, for dealing with such water conditions. In either case a duplicate hoisting engine may be employed for the purpose of raising water only. This system of sinking through water in circular shafts has been successfully employed in Great Britain, two complete hoisting sets being employed for raising dirt and water respectively. Where sinking pumps are required, they can be more conveniently handled in a circular shaft, where more space exists in which the attendants can work.

Since the introduction of the cementation process for shaft-sinking, the question of dealing with abnormal quantities of water has been practically settled, and consequently the usual consideration and precautions which must be taken for a wet sinking are very much less. The chief features of this process, however, as relating to the best type of shaft to adopt in connection with it, and which are of considerable importance, are as follows: (1) a more certain and efficient treatment of the water-bearing measures, at a smaller cost, is obtainable in the case of a circular shaft; (2) the circular shaft is more suitable for fixing a water-tight lining, behind which every small leakage of water from the treated ground can be closed off.

The majority of modern circular shafts are devoid of any serious obstruction, such as buntons or girders for guides (with the exception of water or compressed air columns and cable supports), as a result of the employment of steel rope guides. The frictional resistance to ventilation from this cause is therefore reduced to a minimum in a circular shaft, as compared with that presented by the systematic timbering in a rectangular shaft. In the case of mines having extensive workings and necessitating the installation of large capacity fans, the reduction of shaft friction to a minimum is a matter of the greatest importance, resulting in substantial increase of ventilation efficiency, and consequent reduced running cost

The actual superficial area excavated when sinking a circular shaft having a diameter of 20 ft. inside of walling is approximately the same as that required to sink the Randfontein rectangular shafts now being sunk, 13 by 28·5 ft. actual excavation and 10 ft. 7 in. by 26 ft. 3 in. inside wall plates. But in the circular shaft 86·53% of the superficial area excavated is available air space, while in the Randfontein rectangular shaft only 75% is available. In the case of No. 5 Crown Mines shaft, 9 by 45 ft. actual excavation and 6 ft. 6 in. by 42 ft. 6 in. inside wall plates, only 68·2% of the actual area excavated is available, and a great deal less when taking into account the area occupied by the extensive internal timbering. A comparison of the above-mentioned three shafts, from the point of view of eventual air space for area excavated, shows that the circular shaft is preferable by a very large margin, and that the old elongated rectangular type is distinctly unsuitable.

As regards the superficial area available for hoisting in these three types of shafts, the position is approximately as follows: Crown No. 5, 179·3 sq. ft; Randfontein 194·9 sq. ft.; Circular (20 ft. dia.) 156 0 sq. ft. with rigid guides; two cages, rope guides, 142·5 sq. ft.

From these figures it appears that the rectangular shaft offers the greatest hoisting space for a given area excavated, more particularly the Randfontein type. The point of interest is that the Randfontein shaft, compared with the old type of rectangular shaft, offers for a given area excavated greater air space and larger hoisting area, and it also requires less timber to equip it. While the circular shaft fails in hoisting area, which to a great extent can be met by the employment of large units and faster hoisting, it surpasses all types of rectangular shafts in other respects.

In the author's opinion, down to a depth of 2,500 ft., or even 3,000 ft., with ample clearance, there is no form of guides to compare with rope guides for smooth, safe, and fast running. A rectangular shaft is not suitable for rope guides. One of the essentials for perfect guiding of a cage or any form of receptacle running in a shaft is to guide it by its extremities to avoid oscillation. The points at which the body is attached to a guide should be as distant as possible within practicable limits, calling for large compartments, which is a feature of circular shaft equipment as compared with rectangular shafts. The usual practice of guiding a cage or skip in rectangular shafts allows of the maximum oscillation and rougher riding, resulting in high maintenance cost, limited speed of winding in conjunction with safety, and the necessity of additional hoists to meet the output. There is no comparison in the life and cost of steel or rigid guides with rope guides; provided rope guides are constantly kept well greased, they have almost an unlimited life, particularly if the winding rope is of a non-twistable type and the rope guides are specially built.

The disadvantages of rope guide equipment are: (1) the limit of depth at which rope guides can be used with safety. This depth will depend in a great measure on the clearance, speed of hoisting, and the steadiness of the wind. With an electrical equipment, there would not be any difficulty in equipping a shaft with rope guides to a depth of 3,000 ft., and winding at maximum speed of 4,000 ft. per minute. Great care must be given to freedom from vibration. In shafts upwards of 3,000 ft. in depth it would probably be wise to avoid the use of rope guides; in such cases rigid guides are generally adopted, and work exceedingly well. (2) The necessity for very powerful and heavy headgear, the extra weight of guides and weights being carried by the headgear.

These disadvantages, however, do not prevent the use of circular shafts for greater depths, provided buntons are installed to carry the rigid guides. By the use of rigid guides increased space becomes available for hoisting compartments, as there is not the same necessity for clearance. The author advises the sinking of a rectangular shaft when the number of compartments required exceeds four. The largest diameter circular shaft to his knowledge is 25 ft.

The main advantages of circular over rectangular shafts, exceeding depths at which rope guides are used, are chiefly in the first cost of sinking, and afterwards maintenance, strength of shaft, and ventilation.

Under favourable conditions, sinking in hard quartz rocks, with water not exceeding 2,000 gallons per hour, 7 ft. to 9 ft. a day can be sunk in three shifts of eight hours. This rate of sinking does not include walling or shaft lining. Fifty to 60 feet of walling per day of three shifts is good work. Walling and sinking do not proceed at the same time. The No. 14 shaft, Crown Mines, 20 ft. diameter (inside walling), was sunk and walled to a depth of 3,200 ft. in 21 months, including the cutting of two lodge rooms and sumps, capacity to hold 50,000 and 75,000 cubic ft. The shaft bottom arches, 25 by 23, were also cut and walled, and included in the work at a final cost of £23. 14s. 10d. per foot sunk. The cost of walling varies from £4 to £6 per foot, depending on the thickness of walling and the nature of the walling. The higher costs will cover ordinary water-tight walling. The walling consists of concrete blocks made on the spot, 6 by 9 by 12 in., shaped to the shaft

Mr. Stuart Martin, after the three papers had been discussed, submitted further remarks. He said that from the general remarks made by the advocates of rectangular shafts, it would appear that the great disadvantage of circular shafts is in dealing with heavy feeders of water during sinking; and these gentlemen are prepared to throw over all the advantages of circular shafts owing to this possibility, as against rectangular shafts, where two or three engines can be readily made to operate in the various compartments, and large quantities of water can thus be conveniently baled and sinking proceeded with, without serious delay. He would admit that, with only one winding engine, heavy feeders of water in a round shaft are a source of delay, and delay means additional cost. However, engineers are at fault if they attempt to sink a shaft, whether round or rectangular, if they do not provide proper equipment, particularly if the chances are that water in considerable quantity is likely to be met with. Engineers are again at fault if they maintain that a circular shaft prevents the use of a second winder, or even a third. If two or more winding engines are required for a circular shaft, the shaft should not be less than 20 or 21 ft. in diameter. One winder is all that is necessary for actual sinking operations. The additional engine would only be required for baling

There are two methods for fixing up baling engines in a circular shaft, apart from the central engine for sinking purposes, which can be used for baling up to a certain quantity: (*1*) by running dipping tanks on rail guides; (*2*) by running dipping tanks on rope guides. The use of dipping tanks running on rail guides necessitates the use of buntons in the shaft. The use of guide ropes requires no buntons or shaft equipment at all, the main or collecting tank being hung off two ropes from a geared slow-running double drum winch, one end of each rope being fastened to the headgear, the other end on the drum, thus providing four ropes in the shaft, carrying in suspension the collecting tank, which is allowed to hang freely but not allowed to oscillate, free to move up and down, keeping the ropes taut, the tank being supported by guides clamped to shaft walling, thus preventing swaying from side to side. Pulleys are arranged underneath the main tank diagonally for the ropes to pass under. Thus at any time the tank can be raised or lowered. A separate baling engine is used, working in balance, and two dipping tanks baling from the main tank.

By fixing the dipping tanks rigidly to the rider with extended arms, and designing the dipping tank with minimum section area and maximum length, the steadiness of wind is assured and minimum time is lost in dipping and getting away. All water caught up in the shaft above the main tank is led down to the tank from the last water garland. When heavy feeders of water are at first met with, a low lift sinking pump (one or more) is used to pump water from the shaft bottom to the main tank, a maximum distance of 50 ft. Ordinary quantities of water up to, say, 2,000 gallons per hour can be dealt with, without hindrance to the sinkers, by baling with the sinking engine. The quantity of water that can be handled in this way with one baling engine will, of course, depend upon the size of the dipping tanks and speed of winding and depth of wind.

If large quantities of water are anticipated, then, as the sinking proceeds in depth, lodge rooms can be cut in the shaft, relieving the baling by the erection of pumps in the shaft lodge rooms. In a deep shaft it would probably be wise to make such provision at intervals of 1,000 ft., always keeping the balers free to meet sudden outbursts of water at the shaft bottom, otherwise sinking may be delayed. Ordinary quantities of water can always be held up during walling by the use of water-tight walling. A round shaft 20 ft. and upwards would provide room for two of such installations, if required, using a 3 ton dipping tank; and down to a depth of 2,000 ft., six tons of water per minute could be handled. Allowing 20% for delays, spills, etc., say, 60,000 to 65,000 gallons per hour could be dealt with from the bottom of a sinking shaft with two sets of tanks. If the water anticipated should reach this figure, the author advises that the cementation process be adopted. Very large quantities of water have been dealt with in other mining fields without having to resort to permanent duplication of plant and shaft capacity. However, the point is that a circular shaft can be sunk by the use of proper equipment to deal with heavy feeders of water, and where heavy feeders of water are expected, it is not necessary to resort to rectangular shafts.

Mr. Martin also describes an elliptical shaft.

MAGNESITE, ITS OCCURRENCE AND USES

(Concluded from the April issue, page 219).

We conclude herewith our reprint of Mr. T. Crook's paper on Magnesite, read at the Swansea meeting of the Ceramic Society. Previous portions of the paper have appeared in our issues of February, March, and April.

HYDROMAGNESITE.—Hydromagnesite is a hydrated basic carbonate of magnesium, the formula of which is generally given as $3MgCO_3$, $Mg(OH)_2$, $3H_2O$. It usually occurs in white chalk-like masses, not much unlike some forms of magnesite in appearance, but rather soft and easily powdered. The mineral sometimes occurs as thin crystalline incrustations, and occasionally assumes a globular form. When crystalline it consists of small monoclinic prisms. Its low specific gravity (about 2·1) and the fact that it gives off water copiously when heated in a test tube afford a ready means of distinction from anhydrous magnesite.

Hydromagnesite occurs as an alteration product of other magnesium minerals at many localities, but usually in such small amounts as to be of no economic significance. A few interesting occurrences in Canada, Ceylon, and the United States are described below.

Canada.—Of the various Canadian occurrences of hydromagnesite the most important at the present time appear to be those near Atlin in British Columbia, which have been examined and described recently by G. A. Young. The deposits are situated close to Atlin; one of the two chief groups of deposits is only about half a mile from Atlin wharf, and the other is on the south-east border of the town site.

The hydromagnesite is pure white, rather soft, and falls to powder on drying. Some of it is very wet in the natural state and may lose as much as 22% of water at 105°C., but most of it appears to be fairly dry, except for chemically combined water. Where saturated with water the deposits are so situated as to facilitate ready drainage. The mineral is exposed at the surface, and can be won by open quarrying without the removal of any overburden.

The largest deposit in the first group already referred to (about half a mile from Atlin wharf) covers about 18 acres, and appears to have an average thickness of 2 ft. 8 in. The deposit was sampled in two pits at different depths. One of these pits was in the south-eastern portion of the deposit at a point where the total depth was 2 ft. 2 in., the other was in the northern part of the body at a point where the thickness was 3 ft. 6 in. The following analyses (given in the table at the head of the next column) of samples collected in these two pits were made on material dried at 105°C., at which temperature the loss of water varied from 1·31 to 2·64%:

	South-eastern Pit			Northern Pit		
	D'pth 3 in	D'pth 1ft 1in	D'pth 1ft 11in	D'pth 4½ in	D'pth 1ft 1½in	D'pth 2ft 3in
	%	%	%	%	%	%
Silica (SiO_2) ...	1·86	0·90	0·54	1·22	1·96	9·22
Alumina (Al_2O_3) ..	0·67	0·10	0·17	0·67	0·14	0·94
Ferric oxide (Fe_2O_3) .	0·15	0·09	0·11	0·18	0·45	0·73
Ferrous oxide (FeO) .	0·60	0·45	0·64	0·63	0·65	0·78
Lime (CaO)	2·04	0·82	0·8	1·26	1·50	6·44
Magnesia (MgO) ..	41·13	42·55	42·19	40·56	41·93	35·23
Carbon dioxide (CO_2) ..	35·98	36·10	36·17	35·96	36·04	37·70
Water (H_2O) .. .	18·02	18·95	19·05	19·04	17·66	8·20
Totals	100·45	99·76	99·59	99·52	100·33	99·24

The second group of deposits (that on the south-east border of the town site) consists of three large bodies of hydromagnesite that lie in shallow valleys depressed 30 to 75 ft. below the surrounding country. The mineral in this group of deposits is wetter than that of the first group, and analyses show losses of water up to 21·77% at 105°C. The largest of the three deposits varies in thickness from 1 ft. to 5 ft., with an average of 3 ft. Two samples from different parts of this deposit lost respectively 1·21 to 1·18% of water at 105°C., and gave the following results on further analysis:

	No. 1	No. 2
	%	%
Silica (SiO_2)	0·74	3·48
Alumina (Al_2O_3)	0·35	2·85
Ferric oxide (Fe_2O_3)	0·15	0·56
Ferrous oxide (FeO) ..	0·66	0·81
Lime (CaO)	0·32	0·42
Magnesia (MgO)	42·85	38·94
Carbon dioxide (CO_2)	36·35	34·31
Water (H_2O)	19·10	19·10
Totals	100·52	99·47

It is estimated that the two groups of deposits contain approximately 180,000 tons of hydromagnesite in beds ranging from about 1 ft. to 5 ft. in thickness. It is reported that about 200 tons of the material was shipped to San Francisco in 1904 and that some was sent to England. During 1915 a trial shipment of some 500 tons was sent to Vancouver. The district is stated to be easily accessible by way of the White Pass and Yukon Railway from Skagway, Alaska, to Carcross, Yukon Territory, and thence by a bi-weekly boat service on Tagish and Atlin Lakes.

Another locality in British Columbia where, according to G. C. Hoffmann, hydromagnesite occurs in considerable abundance is that near the 180 mile house on the Cariboo Road, 93 miles north of Ashcroft, in Lillooet district. At this locality there are three or four deposits from fifty to a hundred feet across, standing a foot or more above the level of the surrounding surface, and the hydromagnesite is traceable from one to the other of these deposits over an area of some fifty acres of ground. A shaft sunk in one of these deposits passed successfully through about 5ft. of the pure white material, a layer of about 6 in. of the same of a somewhat yellowish colour, a layer of some 3 ft. of the pure white material, a layer of 18 in. of the yellowish coloured material, an apparently thin layer of the pure white material, and finally reached what evidently constituted the bed of the deposit, namely, a dark-coloured mud containing a few well-preserved shells. On another of these deposits a shaft is stated to have been carried to a depth of 30 ft. without the bottom being reached. The material examined consisted of a pure white, somewhat compacted, yet readily friable aggregate of fine crystalline particles with a few intermingled rootlets. An analysis by R. A. A. Johnston gave :

	%
Magnesia (MgO)	43·71
Lime (CaO)	0·10
Carbon dioxide (CO_2)	37·03
Alumina (Al_2O_3)	0·02
Ferric Oxide (Fe_2O_3)	0·04
Phosphorus pentoxide (P_2O_5)	0·30
Soluble silica	0·38
Insoluble, chiefly silica	1·53
Water with a little organic matter	17·79

An analysis of the insoluble portion showed that of the 1·53%, 1·35 consisted of silica and 0·10 of alumina.

It is thought that the origin of these deposits is connected with the occurrence of the later Tertiary volcanic rocks, basalts, etc, which are abundant in the area referred to.

An occurrence of hydromagnesite is reported as having been found by J. Mackintosh Bell in the form of white encrusting masses, in part showing a globular structure, in cavities of a porous and highly weathered dolomite on the south shore of Dease Bay, some thirty miles south-west of Fort Confidence, Great Bear Lake, Mackenzie District, North-West Territory.

Ceylon.—Hydromagnesite has been reported by the late James Parsons in connection with the work of the Ceylon Mineral Survey, as occurring in the nitre cave at Padiyapelella, in the Central Province, Ceylon. This material had been previously described by Dr John Davy in "An Account of the Interior of Ceylon" (London, 1821) as magnesite, and had been used locally as a sort of whitewash, for which purpose it was sold in small quantities at one rupee per pound. The formation of the cave is due partly to solution action, and partly to quarrying, in a band of crystalline "limestone," which is presumably a metamorphosed dolomite. The hydromagnesite has probably been formed by the decomposition of the metamorphosed dolomite, on which, and on the associated gneisses and other metamorphic rocks, it occurs as encrusting matter, partly in nodular form. These Ceylon dolomites frequently contain forsterite (an olivine) and other magnesium silicates formed by thermal metamorphism. The forsterite readily hydrates to serpentine, and through the action of carbon-dioxide solutions suffers further decomposition. The formation of the magnesium carbonate is probably due in part if not altogether to the action of carbon-dioxide solutions on the forsterite and serpentine in the dolomite. An analysis of a sample of the material by Davy showed 86% of magnesium carbonate, 9 of silica, 5 of water, and only a trace of lime. A sample analysed at the Imperial Institute showed 33·3% of magnesia and 16·04% of lime, and seemed to indicate that the material probably consisted of a mixture, including perhaps magnesite, and calcite or dolomite, as well as hydromagnesite.

United States.—An interesting occurrence of hydromagnesite is reported by H. S. Gale in the forks of Larious Creek, San Benito Co., California. Larious Creek is a locality at which there occurs a large vein deposit of compact magnesite in serpentine, The hydromagnesite forms a white deposit of limy appearance on a weathered surface of sheared serpentine. Associated with this weathered crust there are small globular masses of hydromagnesite, and the following is an analysis of a picked specimen of these from the white powdery material on the weathered surface :

	%
Magnesia	40·60
Lime	0·34
Silica	2·50
Alumina	0·13
Ferric oxide	0·44
Carbon dioxide	34.89
Undetermined	20·10
Loss on ignition	54·10

COMPARISONS.—In considering the relative merits of the different types of magnesite as raw materials for refractory uses, we may perhaps rule out hydromagnesite as comparatively unimportant, or couple it with compact magnesite, and distinguish three types, namely : (1) breunnerite, which is spathic and ferriferous ; (2) non-ferriferous spathic magnesite, which may be to a considerable extent dolomitic and therefore calcareous ; and (3) compact magnesite, which is typically neither ferriferous nor calcareous to any considerable extent.

In comparing these different types, the advantage due to coarseness of texture should be mentioned, especially in the case of breunnerite. In a spathic magnesite or breunnerite of coarse texture, any admixture of dolomite impurity is likely to be less intimate than it is when the texture is fine, and the fragments obtained by coarse crushing are therefore likely to be purer. Moreover, as already mentioned, breunnerite blackens when calcined, and for this reason can be more easily cleaned from impurities by hand-picking, while it can also be dressed magnetically to exclude dolomite, and in this way the quality of the sinter can be controlled.

A further advantage possessed by breunnerite is that ferrous carbonate loses its carbon dioxide at a rather lower temperature than does magnesium carbonate ; but it seems unlikely that the comparatively small percentage of ferrous carbonate present in breunnerite as used for sinter-production, can on this account alone confer the great advantage in effective sintering and kiln-economy that has been claimed for breunnerite, as compared with compact magnesite. There are, however, other factors to be considered, and the settlement of this question appears to call for investigation.

Perhaps the formation of magnetic iron oxide by calcination increases the thermal conductivity of the mass very substantially, and if so the sinter yielded by breunnerite should attain the temperature of the kiln more quickly and more uniformly than should the purer magnesia yielded by non-ferriferous magnesite. Another factor that should perhaps be considered is the oxidation of the ferrous oxide, whether in the formation of magnetic oxide or in the further reaction to form magnesioferrite. The effect due to any disseminated granules of pyrite and other impurities that may be present should also be taken into account.

What the relative importance of these different factors may be it would perhaps be difficult to say ; but it seems clear that, in the sintering of breunnerite, we have fairly definite physical and chemical changes of a not very mysterious character, and that these changes afford an explanation of the kiln-economy that is claimed for the sintering of breunnerite as compared with compact magnesite. We may sum up these changes briefly as follows: (1) The effect of the cleavages in giving the kiln gases access to all parts of the mass; (2) the formation of magnetic oxide of iron, which involves oxidation and which perhaps increases the thermal conductivity of the mass; (3) the segregation of the iron oxide through its combination with the magnesia in the last stage of sintering to form magnesioferrite, which at the end of the operation is scattered in the form of microscopic granules through a matrix of crystalline magnesia (periclase).

If we accept this explanation of the sintering process in the case of breunnerite we are led to infer that the sintering or dead-burning of compact magnesite of the Grecian or Salem type should not present any extraordinary difficulty, though it may involve a slightly greater expense in fuel and more resourceful kiln management. Practice in these matters is, of course, much more important than theorizing. The fact seems clear, however, that the end-product (periclase) of sintering in the case of breunnerite is essentially the same as for compact magnesite; and it seems easier to admit that the actual temperatures of transformation from amorphous to crystalline magnesia are the same in the two cases, than to admit that they are widely different.

We can quite easily understand why the expulsion of carbon dioxide and the operation of sintering should be effected somewhat more economically with breunnerite than with compact magnesite; but the disadvantage suffered by the latter in this respect does not appear to be one that resourceful kiln-construction and kiln management cannot overcome. It is therefore interesting to note that, as already indicated, the Anglo-Greek Magnesite Company appears to have made substantial progress in this direction.

More serious, perhaps, from the refractory standpoint, is the frequency with which quartz and serpentine abound as impurities in compact magnesite and dolomite in saccharoidal magnesite, and the difficulty of eliminating these impurities so as to obtain a product of such steady quality as that which can be obtained by dressing breunnerite.

Even if that difficulty could be overcome, however, there remains the larger economic questions as to the costs and production of transport, and proximity to fuel supplies. In all these respects the advantages enjoyed by the Austrian industry are very substantial, and however pleasing it may be to know that we are not dependent upon Austrian supplies, there can be little doubt that the restoration of normal conditions will make competition with the Austrian industry a difficult matter, so far as the production of cheap and useful magnesia sinter is concerned.

The manufacture of bricks is of course a rather different question. The value of bricks, which is comparatively very high, depends for the most part on the cost of manufacture, and from this point of view our manufacturers doubtless regard sinter as raw material. Perhaps it would be as well, with the high freight-costs now ruling, to adopt this view more seriously, and apply it to Greek and Salem magnesite also, for it would seem to be much more economical to import sinter than to import raw magnesite. Another reason for doing this is that it should be possible to standardize the sinter more economically at the place where the magnesite is mined.

PROSPECTS.—The prices of raw magnesite and calcined magnesia in New York during 1914 were as follows: Grecian crude, \$7 to \$8; Grecian caustic (fine-ground in paper-lined barrels), \$25 to \$35; Austrian sinter (crushed or fine-ground) \$16½. The normal f.o.b. cost of raw Grecian magnesite since the war started is stated to have been about 27 francs per ton, while that of caustic hard-burnt, and dead-burnt, in bags, is given as about 125 francs per ton. According to a recent United States Commerce Report, one mining company in Greece has stated that its prices before the war were \$4 per ton for raw magnesite f.o.b. port of lading, while in March, 1917, it could easily obtain \$7 50 per ton. The Tableaux Statistiques du Mouvement Minier de la Grèce during 1916 indicates that values of magnesite sold by the larger companies in Greece averaged from about 41½ francs per ton for Mantudi to 46½ francs for Limni magnesite, due presumably to the large demand in the United States. The average value given for dead-burnt magnesia during that year is about 151 francs per ton for Limni and 218 francs per ton for Mantudi. In the *Chemical Trades Journal*, London, for July 11, 1914, calcined magnesite was quoted at £5. 15s. per ton f.o.b. makers' works or usual ports, while on July 5, 1918, the price was £14 per ton. On July 12, 1918, the price quoted was £16 per ton, and on the 19th of the same month calcined magnesite had risen to £35 per ton. The notable feature of these prices is the high cost of Grecian caustic compared with Austrian sintered magnesia in pre-war days, presumably owing to the large demand for white caustic magnesia for cement-making and other purposes. It is well that this fact, and the further fact that Austrian sinter can be exported at such a cheap rate in normal times, should be kept in view in any attempt we may make to deal with the prospects in magnesite production.

Bricks made in the United Kingdom from imported Greek and Indian magnesite are likely to cost more than those made from Austrian sinter under normal conditions.

Whether in view of the costliness of magnesia bricks as compared with sinter it may be economically feasible to continue the manufacture of bricks from Grecian or Salem magnesite is a point worth discussing. Freights would be economized, as already mentioned, by the importation of refined sinter in place of crude magnesite; but makers in this country may not find it profitable to continue the production of bricks from Salem or Grecian or other such sinter after the war except for special uses. It seems clear that the costs of such supplies would substantially exceed those of Austrian sinter, and the fact that neither Greece nor India finds it worth while to export sinter in a large way can scarcely be regarded as a promising feature. It rather looks as if producers of the raw material are waiting expectantly under the impression that the return of normal conditions will permit the Austrian exports to dominate the refractory magnesia market in the future as they have done in the past,

The economic advantages that favour the Austrian export trade have already been mentioned. One of the most important of these advantages is the open-cut working of large deposits of breunnerite, the nature of which permits of the production of standard qualities of sinter at cheap rates. It would perhaps be unreasonable to expect that sintered magnesia should be produced at such a cheap rate under the less favourable mining conditions prevailing in Greece, Italy, India, and California. What then are the prospects as regards competition from other large spathic magnesite deposits which are more fairly comparable with those of Austria-Hungary?

The two deposits that have come into prominence during the war as large producers of spathic magnesite for refractory uses are those of Quebec and the

State of Washington in North America. The deposits in both these areas are extensive, and their potentialities as producers are amply indicated by their very rapid development during the last two or three years to meet the demands arising from war conditions. In both these cases, however, the refractory magnesia produced is much more expensive than the sinter of Austria-Hungary. The Quebec product contains more lime than is desirable; but according to a report in the Canadian Mining Institute Bulletin for January, 1918, the Quebec sinter was then selling at the rate of $50 per ton, which is rather more than three times the price at which Austrian sinter sold in the New York market during 1914. Even assuming, therefore, that it may be found possible to produce from the Grenville deposits a sinter as low in lime as desirable, there remains the question whether it can be produced at a sufficiently cheap rate to compete with the Austrian.

The spathic magnesite now being produced from the deposits recently opened up in the State of Washington is of good quality, but even assuming that this quality can be maintained, the large freight charge this magnesite has to face in getting to the eastern markets will prove a serious handicap to the companies mining these deposits when normal conditions return. The prices quoted free on rail at Valley and Chewelah in Washington State during 1917 were $7½ per ton for crude and $32½ for calcined. Adding freight charges to this rate for calcined gives a total cost in the Eastern States comparable with or exceeding that of Canadian.

Judged by comparison with the exceptionally high costs of ocean freights now ruling, these land-freight costs are not heavy, but time will readjust this order of things, and again bring into relief low costs and efficiency of production as factors in the economic situation. It is to be hoped that, meantime, producers of magnesia bricks in Britain and other parts of the Empire will have taken full advantage of the period of absolute protection that war conditions have afforded them, and will have succeeded in establishing the industry on a firm basis.

Magnesite occurrences remind us how precious are those wasting assets of the earth, its useful mineral deposits, on the exploitation of which extensive civilization depends for its maintenance. This is especially true of the compact type of magnesite, which previous to the war was wanted chiefly for use in making oxychloride cement, and is still wanted very much for the same purpose, to say nothing of its growing importance as an ore of magnesium.

Mr. Hogg has told us that the Grecian deposits cannot be expected to persist to any considerable depth, and, as already pointed out, he estimates that Eubœa has only a few years to run as a large producer of cheap magnesite. His experience as regards the shallow depth of this type of magnesite is in agreement with that of mining engineers elsewhere; and in the opinion of the present writer it is also in agreement with the best explanation that can be given of the origin of compact magnesite, namely, that it has been formed at comparatively shallow depths by the action of carbonic acid in solutions of subaerial origin.

It is otherwise with the deposits of spathic magnesite and breunnerite, which owe their origin to metamorphism at greater depth; and, if we take a large view of the world's economy, it is to these deposits that the smelting industries should look in the future, as they have done in the past, for the large supplies of refractory magnesia they require, leaving most of the compact magnesite to those who need it for cement-making, magnesium-alloy production, and other uses in which the chemical purity of the raw material is more essential than it is in the refractory magnesia required for the ordinary purposes of metallurgy.

It seems indeed almost inevitable that future readjustments will be along these lines; but whether so or otherwise, the present position is such as to show clearly the need there is for a vigorous investigation of magnesite resources. There are no doubt many deposits waiting to be found and developed. Italy furnishes a good example in the development of her large deposits at Castiglioncello, which have only recently come into prominence.

The compact type of magnesite, however, is a conspicuous object at the surface, and falls a ready prey to the prospector. The spathic type is not so easily discerned, and calls for closer vigilance. On that account we may perhaps reasonably expect good practical results to follow from an investigation of crystalline dolomites in metamorphic areas; and it may be suggested to those geologists who have the opportunity of making such field investigations, that by giving attention to this matter they may at the same time be able to shed more light on one of the most fascinating problems in rock-genetics, namely, the origin of spathic magnesite and breunnerite.

ENRICHMENT OF TUNGSTEN ORES.

In *Economic Geology* for February, R. W. Gannett describes a series of experiments undertaken with a view of studying the reactions in nature tending to enrich tungsten ores. The purposes of this work were: First, to determine the effects of various solutions, such as are found in ground waters, on tungsten minerals; second, to determine what natural reagents might precipitate tungsten from solution. Though there are many other tungsten minerals, only scheelite and minerals of the wolframite series (ferberite, wolframite, and hübnerite) are considered, for these are the only commercial ores. The paper presents results obtained from the leaching of tungsten minerals, obtained from precipitating tungsten from solution, and interpretations of the results.

The object of the leaching experiments was to determine the effect of various solutions, resembling ground waters, on the tungsten minerals. Solutions approximately tenth normal, or their mixtures, were used, except in cases where the solubility was too low or where it was impracticable, as with CO_2 and humic acids. The solutions used were: Sulphuric acid, calcium sulphate, sodium sulphate, ferrous sulphate, ferric sulphate, manganous sulphate, carbonic acid, sodium bicarbonate, calcium bicarbonate, hydrochloric acid, sodium chloride, ferric chloride, manganous chloride, sodium hydroxide, and humic acids. A little H_2SO_4 to prevent hydrolysis was used with the iron sulphates, and a little HCl with the sodium and iron chlorides. The scheelite used was from the Argentine. It was a nearly pure crystal, light yellow brown in colour. The ferberite was mill concentrate from Colorado. It contained practically no manganese. The wolframite was from South Dakota, and was rather impure, containing 8% of silica. It has a ratio of iron to manganese as 6 to 1.

The ferberite, wolframite, and scheelite were ground to pass 100 mesh. About 1 gramme was weighed out in a test-tube, and into this 40 cubic centimetres of solution was poured. Qualitative tests were made at intervals during the experiments, 1 cubic centimetre of solution being withdrawn each time; three such portions were taken during the course of the experiments. Quantitative analyses were made on the solution that remained. The solutions were tested for tungsten as follows: one cubic centimetre of solution was withdrawn with a pipette and put into a small test-tube with 1 cubic centimetre of concentrated HCl. A piece of tin was added, and the solution heated until hydrogen was being rapidly evolved; the colour of the blue oxide of tungsten was the indicator.

The lime in solution from the scheelite was tested for by a drop of solution added to a cubic centimetre of a mixture of ammonia and ammonium oxalate; the amount of white precipitate was the indicator. Iron was tested for by placing a drop of solution with a drop of HNO_3 and adding a drop of ammonium sulphocyanide. The red colour was a sensitive indicator.

The following is a summary of the results: (*1*) Carbonate solutions had no apparent effect on any of the tungsten minerals. (*2*) Alkali hydroxide solutions had no effect on scheelite, but dissolved tungsten from the wolframite. (*3*) Salts of lime and soda, in the absence of acids, had no apparent effect. (*4*) Sulphuric acid alone, and in combination with sulphates of lime, soda, manganese, and ferrous iron, dissolved portions of all the minerals. (*5*) Hydrochloric acid alone, and in combination with chlorides of lime, soda, and manganese had a solvent effect on the minerals. (*6*) Manganous salts invariably gave increased solution. (*7*) Ferric salts in most cases seemed to inhibit any reaction, but in the case of scheelite the reaction is not completely stopped, although it is reduced to small proportions In the case of ferric chloride, the acid present did not prevent hydrolysis, so the active solution contained no ferric chloride, but was instead faintly acid, and so had a solvent action. (*8*) Sulphate solutions are more active than chloride solutions. (*9*) Manganous solutions, and possibly ferrous solutions, brought about an interchange of lime from the scheelite with the manganese, and possibly with iron of the solutions. (*10*) The more active solutions left an H_2WO_4 precipitate in the test-tubes with scheelite. (*11*) Humic acids are inactive. (*12*) Except by sodium hydroxide, scheelite is more readily attacked than ferberite or wolframite. (*13*) Wolframite and ferberite, while giving the same general results, are attacked in different degrees by different solutions.

Experiments relating to the precipitation of tungsten from solution were made to determine what natural reagents would precipitate tungsten from solutions such as are found in nature. A solution of sodium tungstate was made (0·071 normal), and portions of 10 c.c. each were mixed with the same quantity of the solutions similar to those used for leaching tungsten. The immediate effect was noted, the effect shortly after, and also the effect after a considerable time. The results are summarized as follows: (*1*) Calcium tungstate is precipitated from solutions by lime salts when slightly acid, but the precipitation of tungsten is incomplete. (*2*) Manganous and ferrous tungstates are precipitated by manganous and ferrous salts in neutral solution. The precipitation is complete, or nearly so. (*3*) Acids partly precipitate the tungsten as tungstic acid. (*4*) Ferric chloride, in slightly acid solution, completely precipitates all the tungsten as a hydrous ferric tungstate. (*5*) Manganous tungstate is precipitated by manganous salt in slightly acid solution; the reaction is incomplete. (*6*) Ferrous tungstate is not precipitated in acid solution, but is precipitated in slightly alkaline solution; the reaction is nearly complete.

Carbonate solutions, as shown above, do not attack tungsten minerals; any enrichment of tungsten deposits by carbonate solutions is brought about only by the removal of valueless material.

The sulphides usually present in ore deposits are the sources of sulphuric acid. As shown above, a leaching of tungsten deposits by such solutions might be expected, although the tungsten, if much is present, is partly precipitated by acid. This occurs only when the concentration of the tungstate ion in solution is sufficiently high. As shown by the experiments, H_2SO_4 on scheelite will dissolve some tungsten, and leave some as tungstic acid. The same probably occurs with wolframite to a smaller extent. This would indicate that sulphuric acid solutions acting on a tungsten deposit remove some tungsten and decompose some to tungstite. The result in terms of enrichment is variable, depending on the ratio of loss of other constituents to the loss of tungsten. The alterations mentioned may be observed in the outcrops of nearly any tungsten vein.

Ferric salts, which frequently are present in ground waters, would prevent, or at least slow down such alteration. Moreover, if any tungsten did dissolve, it would probably precipitate to form a hydrous ferric tungstate, know mineralogically as ferritungstite.

The same statements made for sulphuric acid and ferric sulphate hold for hydrochloric acid and ferric chloride. The chlorides would generally be less abundant in deposits.

Ferrous and manganous tungstates (ferberite, hübnerite) are precipitated more readily and more completely than calcium tungstate (scheelite). One would suppose that in superficial alteration scheelite would be the least common secondary mineral, although it is not unknown as such. Scheelite forms on wolframite in ores of the Black Hills, South Dakota. Manganous tungstate (hübnerite), being more readily and completely precipitated than ferrous tungstate (ferberite), should be more common as a secondary mineral than ferberite. Because ferrous and manganous tungstates are more readily precipitated than calcium tungstate, wolframite is more often pseudomorphous after scheelite than the contrary. The colour changes noted in scheelite which is being leached indicate this principle, as do also numerous illustrations from the field.

Several sets of conditions indicating secondary enrichment of tungsten may be named. The most probable of these may be illustrated by a pyritiferous tungsten deposit. Emmons has shown how the ground waters in a pyritiferous ore-body are acid, and contain ferric salts at the surface, that deeper the ferric iron is reduced to ferrous, and deeper yet the acid is neutralized and the waters become alkaline. At the outcrop, ferric salts would be present, and little or no tungsten dissolved. At a slight depth the ferric salts would be reduced and the ground water still would be acid. At greater depths, the ground waters become alkaline, when the ferrous sulphate will precipitate tungsten.

The evidence of experiments, on the whole, is that tungsten minerals are somewhat soluble. The field evidence seems to point to the same conclusion. It has been argued from the existence of placer tungsten at Tavoy, Burma, that the minerals of tungsten are resistant to weathering. Others have contended that the resistance of tungsten minerals to weathering is less than supposed, and that in some gravel deposits of tungsten the tungsten does not occur in true placers, but in residual and detrital deposits, the tungsten being all dissolved before the mineral is carried far enough to form the true placers which its associate, cassiterite, forms.

After tungsten is dissolved, it is very easily precipitated by ferric salts; but this precipitate is colloidal and difficult to filter. If such a precipitate should form, it might be carried long distances and be widely distributed through the rock without being lodged in a definite deposit, and the deposit thus impoverished in tungsten.

The wide difference between the solubility of wolframite and that of ferberite calls for special comment. The difference is not due to a mineralogic distinction, for that is an arbitrary, not a natural distinction. The manganese compound is more soluble than the iron compound. Field data show that two deposits having apparently the same tungsten mineral are widely different in their resistance to weathering. This remains as yet an unsolved problem. F. L. Hess has suggested that this difference is due to minute quantities of tantalic and columbic oxides, or other impurities often present in tungsten minerals.

If secondary enrichment does occur, it is difficult to interpret in the field; the secondary minerals are the same as the primary minerals; tungsten deposits, moreover, are erratic, and any general change in values with depth is, therefore, unusually difficult to interpret.

The author summarizes as follows: In some deposits, associated minerals other than those containing tungsten dissolve more readily than tungsten minerals, and there is an enrichment near the surface by removal of valueless material. Tungsten minerals, nevertheless, dissolve rather readily, and form soluble salts or colloidal compounds, that may remove the tungsten from the outcrop. The tungsten may be leached from its ore-bodies without being redeposited below. The facility with which tungsten compounds in solution will hydrolyse and form insoluble compounds tends to prevent downward migration of tungsten, and there are probably no extensive zones of tungsten minerals like those of copper and silver, although enrichment by solution and reprecipitation probably does occur to a small extent. Ferric sulphate, which increases the solution of copper and silver, slows down or stops the solution and migration of tungsten. In general, secondary tungsten ores are hübnerite or wolframite, rather than scheelite, although secondary scheelite is not unknown.

Manganese in South Africa.—The *South African Journal of Industries* for January contains an article by Mr. T. G. Trevor on manganese, its occurrence and uses. We extract herewith the section dealing with the occurrences in South Africa.

Until quite recently, the only manganese deposits in South Africa to which attention had been paid were contained in certain fissure veins in the Cape Province and one near Pretoria. During the past year, however, considerable attention has been turned to this subject. Manganese ores are known to occur in the Union in the three main classes of deposit: (*a*) fissure veins and lateroid enrichments on the outcrop of such; (*b*) connected with the dolomites and Moodies series, (*1*) diffused in the dolomites, (*2*) irregular deposits in the dolomite and Moodies series, (*3*) bedded deposits in the dolomite and Moodies series; (*c*) lateroidal deposits derived from dolomites.

Deposits of the first class are fairly numerous in the south-west districts of the Cape Province. Welsh, in his report on them, enumerates seven. In all cases the outcrops were very much larger and richer than the actual veins, showing a distinct lateroidal enrichment of the surface. The manganese content was low and the phosphorus high, the approximate analyses given of the clean hand-sorted ore from the three most important being as follows:

	Mn.	Iron	Silica	Phosphorus
	%	%	%	%
Caledon	38	16 to 20	6 5	0 378
Du Toits Kloot ...	40	13 to 22	0 75 to 4	0 47 to 0·57
Houts Bay	30	9 to 16	6 00 to 2	0 47 to 0·66

Welsh's report shows clearly that these deposits, as at present known, are not sufficiently large or rich to be of economic importance.

Near Pretoria at Derdepoort is a small manganese vein similar to those described by Welsh, but in this case the ore is richer and the vein shows some signs of permanence. The outcrop has been opened for about 40 yards to a maximum depth of some 35 ft.; the fracture dips at a high angle and crosses the formation acutely. At the bottom the manganese (pyrolusite) is about 4 ft. wide and most of it appears of excellent quality. A bulk sample of five bags of ore from this mine analysed in England gave the following results:

	As received	Dry
	%	%
Manganese	55·88	56·10
Iron	2 62	2 63
Silica	1·69	1 70
Phosphorus	0 134	0·135
Moisture	0 39	—

The ore was reported on as being a good hard mineral of satisfactory mechanical condition. The results as regards manganese, iron, and silica are excellent, but the phosphorus is rather high. Until further development has been done it is impossible to forecast the future of this deposit, but the fracture appears a persistent one. If the quality of the ore holds good it should be capable of supplying small quantities of high-grade ore sufficient for the requirements of the Union for electrical and kindred purposes where a high price can be given for an exceptionally pure ore, but for metallurgical purposes the quantity is insufficient.

The dolomites which cover such a great area in the Transvaal and Bechuanaland commonly carry a small percentage of manganese. This is obvious to the traveller from the black manganese-stained rocks and soil which are so often crossed when passing through dolomite areas. In gold-mining in the dolomites, black, sooty deposits of wad are often found, as at Mitchell's Reef in Malmani and other localities. At Ashbury Siding, near Pretoria, a similar occurrence is exposed in the railway cutting. So far as is known to the writer, these deposits are usually poor in manganese and of no great extent. Also lying in the dolomite are bedded deposits of manganiferous material which, if not continuous, occur again and again in approximately the same horizon. Several of these are noticed in the Pilgrim's Rest district, of which one apparently of considerable thickness runs along the east base of Burger's Pass and appears again in a similar position at the foot of Graskop Nek. Another noticeable deposit is that at Ross Hill, portions of which appear to be of good quality. At Goedverwacht No. 32, in the Carolina District, there is a similar very well marked manganese bed in the dolomite, which appears on the outcrop to be of good quality and which traverses the neighbouring farms. In the Vryheid and Utrecht Districts on the farms Bellevue No. 600, Paris (unnumbered), Dwaalhoek No. 105, and Baviaans Krantz (unnumbered) there are beds of magnetic shale, which are believed to belong to the Moodies

Series, carrying a certain amount of MnO_2. Where these have weathered they have given rise to a considerable amount of nodular pyrolusite. At the Devil's Reef, Pigg's Peak, a bed of dolomite in the Moodies Series carries large pockets of apparently rich MnO_2

By far the most important deposits of manganese ore yet opened up in the Union are the lateroidal deposits associated with the dolomite in the Krugersdorp District. These have been opened on the following farms: Elandsvlei No. 6, Daniels Rust No. 19, Brandvlei No. 21, Elandsvlei No. 23.

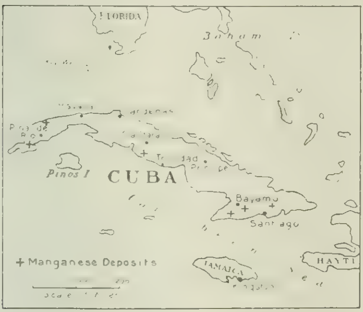
The deposit at Elandsvlei No. 23, which is typical of this class of deposit, is situated about the centre of the farm, the prospecting workings being five miles by road from Randfontein Station, and a similar distance from the Zeerust line. The geological formation hereabouts is the Black Reef Series, but where the deposit occurs there is a covering of red soil, which on being penetrated reveals remnants of dolomite formation in the form of disintegrating chert mixed with clay, lime, and ironstone. It is in this mixture that the manganese mineral occurs, in nodular form, like plums in a pudding. The nodules vary in size from quite small up to 12 or 15 in. in length, the average of the majority being in the neighbourhood of 6 in. The manganese occurs chiefly as dioxide in the form of pyrolusite or psilomelane, and is evidently a replacement mineral, as it occurs as a pseudomorph after oxide of iron, chert, and shale, one of which minerals it is generally found intimately associated with. In fact, nearly every nodule of manganese has a certain amount of yellow oxide of iron attached to it which, even with close cobbing, cannot be entirely detached, and it is consequently almost certain that there will be a high percentage of ferric oxide present. The workings cover an area of about three-quarters of a mile by half a mile, and consist of shallow pits sunk at intervals of a few feet in more or less regular lines throughout the area. These pits vary from a few inches in depth to a maximum in a few cases of about 10 ft., depending chiefly on the thickness of the red soil covering the surface. In some places manganese-containing boulders lie on the surface, so that in such instances little has been done beyond breaking the surface to expose a fresh fracture of the mineral. The amount of manganese ore per ton, or per cubic yard of ground, varies considerably, as proved by an inspection of these pits. In practically every case there are indications of manganese, while in certain instances there are found local enrichments or rich pockets and the nodules become much more abundant and much richer, the pockets apparently tapering off at the edges to a poorer zone containing fewer nodules of small size and generally poorer quality. Three such rich pockets have been definitely located, lying at the corners of a triangle roughly about half a mile distant from one another. There has not been sufficient work done to determine the size or shape of these pockets, but it is a conservative estimate to say that they are 100 yards across and probably much more. Recovery work is being carried on at one of them and nodules are being stacked and cobbed, but no measurements or figures have been taken so far to ascertain the yield or cost of the work. There is little doubt that other enrichments similar to the three referred to will be found, both in the prospected area and outside of it. In addition to the deposits proved by the prospecting pits, there are surface indications in the shape of manganese nodules in the surrounding area for some distance on either side, and as a matter of fact the discovery of similar deposits has been reported from the neighbouring farm Brandvlei, so there is every probability of even richer finds being made in the future. If the ore is suitable for metallurgical requirements, there should be a very large tonnage of the deposit, of which a considerable portion is easily available in the enriched zones, which can be worked at a cheap rate without the outlay of any great amount of working capital. From the certificates of analysis it appears that the cobbed ore from the final heap ready for shipment varies from about 59% to 63% MnO_2.

The areas in the Transvaal and Bechuanaland where the dolomites lie almost horizontally and have suffered from intense denudation are immense, and it appears likely that similar deposits will be found in very many places when sought for, and in the aggregate a large output of marketable manganese ore may be secured in the Union; it is doubtful, however, if these deposits could be worked cheaply enough to compete with the Indian, Russian, and Brazilian mines for the trade of the northern hemisphere, though certainly they should be sufficient for all possible domestic needs.

Manganese Deposits in Cuba.—As mentioned in our last issue, the March *Bulletin* of the American Institute of Mining Engineers makes mention of a lengthy paper by E. F. Burchard on the manganese deposits of Cuba, written for the Institute but not distributed except by request. We give an outline herewith.

Manganese ore is found in Cuba in Oriente or Eastern, Santa Clara, and Pinar del Rio provinces, but in Oriente province only does it occur in large commercial quantities. There, the deposits are in three areas: one north of Santiago de Cuba, one south of Bayamo and Baire, and one on the Caribbean coast between Torquino peak and Portillo. In Santa Clara province, a little ore has been found near the Caribbean coast west of Trinidad; and in Pinar del Rio province, manganiferous material occurs north of the city of Pinar del Rio and farther west near Mendoza. The ores occur principally in sedimentary rocks, such as limestone, sandstone, and shale, that are in places metamorphosed, and in beds that originally may have been water-laid tuff but are now partly replaced by manganese oxide, zeolites, calcite, and other minerals. In the most heavily mineralized localities, the deposits are in and about masses of silicious rock, locally termed "jasper" and "byate" that are associated with the country rock At one locality south of Bayamo, the manganese and its silicious associates are in igneous rocks, such as latite-porphyry and latite. The sedimentary rocks with which the manganese deposits are associated are, in some places, nearly horizontal, but generally show dips ranging from a few degrees to 45° or more. The area north of Santiago is, broadly speaking, in the synclinal basin between the Sierra Maestra on the south and the Sierras de Nipe and del Cristal on the north, the greater part of which is drained westward by Rio Cauto and its tributaries, and small parts of it by Rio San Juan and Rio Guantanamo to the south and east. The deposits are found on both sides of the basin. The deposits in the area south of Bayamo are in the northern foothills of the Sierra Maestra drained by Buey, Bayamo, Yao, and Cautillo rivers. The deposits in the two areas north of the Sierra Maestra show an interesting concordance in altitude. They are from 500 to 1,200 ft. above sea-level, and most of them are at altitudes near 600 to 700 ft., suggesting a relation between the deposition of the manganese and a certain stage in the physiographic development of the region. Most of the deposits are above drainage level on the slopes of hills of moderate height, the maximum relief in the immediate vicinity of the deposits seldom exceeding 500 ft. Some of the deposits have been observed to lie on the crest and slopes of anticlinal hills, but these anticlines are only local puckerings of the strata forming the broad synclinal basin just mentioned. The foraminiferal limestones and greensand marls associated with the manganese ores in the Santiago district, and also probably along the northern foot of the Sierra Maestra south of Baire, are regarded as of upper Eocene age.

The deposits of manganese ore in Cuba exhibit wide variations, but may be grouped into three general physical types: deposits in beds; deposits in irregular masses associated with silicious rock, such as jasper or byate; and deposits in residual clay or rock debris. The term jasper is more commonly used in the Santiago district, byate in the Bayamo district. The deposits in beds comprise several varieties, one of the most common consisting of poorly consolidated beds of sandy, tuffaceous material mixed with manganese



Map of Cuba showing position of Manganese Deposits.

oxides, granules of pink clay, and zeolite minerals. Such beds fill depressions in the surface and crevices and cavities within hard rocks. Other bedded deposits occur as tabular masses interbedded with limestone strata, and others are replacements of limestone, sandstone, and conglomerate beds. Pyrolusite, psilomelane, manganite, and wad, or mixtures of some or all of these minerals, are found in the ore deposits, but no manganese carbonate or silicate minerals were recognized in any of the deposits except in the metamorphosed limestone and calcareous schist near Trinidad, where ankerite and rhodonite occur in small quantities. The richness of the deposits varies considerably. Most of the richest masses are associated with the jasper, but masses that have replaced limestone thoroughly are also rich. The ore known as milling, or wash ore, is generally of the sandy, tuffaceous type, in which it is necessary to separate considerable granular gangue material from the manganese oxide.

The production of manganese ore about the middle of March, 1918, in the Santiago district, was between 280 and 300 tons a day. The output was curtailed in the rainy season, which begins about the first of June, especially that from the smaller mines, which are dependent on ox-cart haulage, but the curtailment was more than offset by the increase in shipments after the railroad from Cristo to the Ysabelita mine was opened. The approximate average composition of a large proportion of the ore recently shipped for metallurgical use is as follows: Manganese, 38·885%; silica, 12·135%; phosphorus, 0·084%; moisture, 11·201%. Although the owners and operators of manganese properties in Cuba desired to speed up production during the period of the war while the need for the ore was great and the prices were good, there were certain hindrances, aside from climatic conditions, that tended to retard their output. These hindrances will, for the most part, continue to affect the manganese industry in Cuba, and unless many of them are removed and others remedied it will probably be difficult to maintain the industry in the face of reduced prices for ore.

Thallium from Pyrites.—The *Journal* of the Society of Chemical Industry for March 31 contains a notice of a paper by George Sisson and J. S. Edmondson on the extraction of thallium from pyrites flue-dust. The authors were engaged in investigations for the recovery of rare elements, such as selenium, at sulphuric acid works. They collected a quantity of dust deposited in the flues from the pyrites kilns into the Glover concentrating tower, at a works at Newcastle-on Tyne. Spanish pyrites is used in these kilns, containing perhaps 2% of copper and small quantities of a large number of other elements, such as bismuth, arsenic, antimony, tellurium, thallium, and selenium, which are volatilized with the sulphur, while the iron, copper, etc., remain in the burnt ore. The more volatile constituents, such as the sulphur, arsenic, and selenium, are carried forward principally beyond the flue into the Glover tower. The flue dust itself consists of materials carried over mechanically, such as iron oxide, small quantities of copper and lead, and volatile substances condensed at the flue temperature of about 450°C., such as antimony, bismuth, thallium, etc. After making several experiments on this material the authors failed to separate any appreciable quantity of selenium; no doubt the temperature of that part of the plant was too high for condensation, the hot gases carrying forward into the sulphuric acid any traces of selenium contained in the pyrites. They then turned their attention to thallium, which was known to occur in such deposits. Although thallium compounds are widely distributed they occur in very small quantities, associated with other metallic sulphides in various ores, and the flue dust of sulphuric acid factories is still the only practicable source. Such dust may contain up to 8%, but only rarely is more than 0·25% of thallium present. The quantity of dust collected by the authors was about 15 cwt. in six months, representing the burning of 1,500 tons of pyrites. The dust contained 0·25% or a total of 4 lb. of thallium, equal to one part per million of pyrites. The method used to separate the thallium depends chiefly upon the sparing solubility of the chloride and the solubility of the sulphate, the operation being to treat the dust with boiling water acidified with sulphuric acid in a wooden or earthenware vessel, using live steam injection; on settling, the clear liquid is treated with hydrochloric acid. The crude chloride precipitate is separated, washed, and converted into sulphate by heating with strong sulphuric acid, the excess of acid is driven off, the remaining sulphate dissolved in water, filtered, and re-precipitated as chloride. The purified chloride after drying is mixed with potassium cyanide and sodium carbonate, and fused in a crucible, care being taken not to use too high a temperature in order to avoid loss by volatilization. Or the chloride may be reduced by zinc and the resulting metal melted in a current of inert gas. Instead of hydrochloric acid sodium chloride may be used to precipitate the thallium from the sulphate solution. The crude dust must be washed repeatedly to extract the whole of the thallium salt. An alternative method is to precipitate the thallium as iodide from the sulphate solution, the iodide being less soluble than the chloride, but the cost of the iodide is an objection.

SHORT NOTICES.

Tunnelling Excavator. The *Iron & Coal Trades Review* for April 11 describes a rotary tunnelling machine invented by D. Whitaker and H. C. Baxter, of Leicester. This machine has been used by the Royal Engineers for boring in the chalk at Dover and at other places.

Coal Cutter.—The *Iron & Coal Trades Review* for April 4 describes a coal cutter invented by E. Appleby, of South Wales.

Concrete in Mining.—*Chemical Engineering and Mining Review* (Melbourne) for February describes the application of concrete lining for shafts and underground ore-bins at the Wallaroo & Moonta Co.'s copper mines. We intend to quote this article in our next issue.

Kotze's Konimeter.—In the February *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa, John Innes gives additional information relating to Kotze's konimeter, employed for estimating the amount of fine dust in the air.

Dust-Preventer.—The *South African Mining and Engineering Journal* for February 22 describes the Swift water-jet attachment for piston drills used for suppressing dust.

Concentrating Pyrrhotite.—*Chemical and Metallurgical Engineering* for March 15 contains a paper by J. P. Bonardi describing the results of tests on the magnetic concentration of pyrrhotite ores.

Re-treating Zinc Tailing.—In the *Engineering and Mining Journal* for March 22, W. F. Boericke describes cheaply-built plant used for re-treating zinc tailing from dumps in the Wisconsin-Illinois district.

Drying.—At the meeting of the London Section of the Society of Chemical Industry held last month, E. A. Alliott read a paper on drying by heat in conjunction with mechanical agitation.

Leaching Copper Ores.—In *Chemical Engineering and Mining Review* (Melbourne), Percy R. Middleton describes the application of the Dorr countercurrent system to the leaching of Australian copper ores.

Leaching with Ammonia.—In *Chemical and Metallurgical Engineering* for April 1, Lawrence Eddy discusses the details of the method of leaching copper ores with ammonia solutions as applied at Kennecott, Alaska.

Oxygen in Cyanidation.—In the *Engineering and Mining Journal* for March 22, N. S. Keith writes on the function of oxygen in cyanidation, tending to show that the process for removing oxygen before precipitation by passing solutions through a vacuum pump presents no novelty.

Air in Smelting.—In the *Engineering and Mining Journal* for April 2, C. H. Smoot describes his regulating apparatus for securing constant volume of air blown into blast-furnaces.

Magnesium and its Alloys.—The *Engineer* for April 25 gives information relating to magnesium and its alloys; a short bibliography adds to the value of the

Guamoco, Colombia. — In the *Engineering and Mining Journal* for March 22, S. Ford Eaton commences an article describing lode-gold mines in the Guamoco district, Colombia, in hills between the Magdalena and Nechi rivers. Gold mining has been done in these mountains by various Americans, and the mine recently acquired by the Oroville Dredging Company is situated here.

Rhodesian Minerals.—The *Bulletin* of the Imperial Institute, Vol. XVI, No. 4, contains an article on Rhodesian minerals, with particular reference to specimens examined at the Institute.

Canadian Platinum and Manganese.—The Canadian Mining Institute *Bulletin* for April publishes an article describing investigations of certain Canadian platinum and manganese resources by G. C. Mackenzie. The platinum occurrences examined were at Fort Saskatchewan, Alberta, and Tulameen, British Columbia, and the manganese deposits were at Lake Cowichan, Vancouver Island.

Magnesite in Venezuela.—In the *Engineering and Mining Journal* for April 12, C. F. Z. Caracristi describes the magnesite deposits in Margarita island, off the coast of Venezuela.

Northern Territory, Australia. — The *Industrial Australian and Mining Standard* for February 13 contains an article on the possibility of developing mineral deposits in the Northern Territory of Australia and the difficulties in the way.

British Columbia.—The *Mining and Engineering Record* (Vancouver) for January consists entirely of a comprehensive review of the progress of mining in British Columbia during the last twenty-five years.

Far East Rand.—The *South African Mining and Engineering Journal* for March 1 commences a series of articles on the southern or Heidelberg section of the Far East Rand and of the goldfields lying to the south-east of Heidelberg.

Korean Mining.—In the *Mining and Scientific Press* for March 29, H. J. Evans and K. F. Hoefle describe the Unsan gold mines belonging to the Oriental Consolidated Mining Co.

Transvaal Tin Mines.—The February *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by Max Baumann on "Ancient Tin Mines in the Northern Transvaal."

Pulverized Coal.—At the meeting of the Iron & Steel Institute held on May 8 and 9, L. C. Harvey read a paper on the use of powdered coal in metallurgical processes.

Pulverized Fuel.—The *Engineer* for April 25 describes and illustrates with full working drawings the locomotive using powdered coal which is being experimentally used on the Great Central railway.

Liquid Fuel Burners.—The *Iron & Coal Trades Review* for April 18 describes a number of burners using liquid fuel such as pitch employed at various works in London district.

RECENT PATENTS PUBLISHED.

2,847 of 1916 (124,513). F. A. FREETH, Liverpool, and H. E. COCKSEDGE, London. Method of extracting potassium nitrate occurring in commercial nitrate of soda.

1,174 of 1918 (124,540). R. MARTIN and J. I. RICHARDS, Swansea. Improvements in the arrangement of rabbles in furnaces for roasting zinc and other sulphides.

4,292 of 1918 (124,038). A. T. MIRZA, Bombay. Furnaces for making zinc oxide from metallic zinc.

4,774 of 1918 (116,263). F. RIGAUD, Paris. Plant for use in the production of nickel or copper sulphate from ores and matte.

4,854 of 1918 (124,266). F. W. HARBORD, London. "A process of roasting complex zinc sulphide ores or concentrates or zinc blende, which consists in injecting the finely subdivided material by a blast of air into an externally heated vertical or inclined muffle chamber so as to bring the material into contact with the incandescent surfaces of the chamber and thus partially to roast the material at the part of the chamber where the injection occurs, the proportion of air used in the injecting blast being sufficient or more than sufficient to burn the desired proportion of sulphur, and the injected material being caused to travel down the chamber to complete the desired degree of roasting."

5,023 of 1918 (124,283). D. DAPONTE and T. F. NEWMAN, London. In coating iron and steel with zinc by the vapour process, giving the objects a preliminary covering of copper or brass.

5,072 and 5,073 of 1918 (124,553 and 124,554). E. E. and P. C. DUTT, Jubbulpore, India. Improvements in the inventors' method of producing alumina from clay.

5,479 of 1918 (114,623). T. MATSUSHIMA, Kanagawaken, Japan. Improvements in the electrolysis of salt by the mercury process.

5,696 of 1918 (124,594). G. H. FORRESTER, Iver, Buckinghamshire. Method of re-melting tin that has been removed from tinplate by sweating.

7,505 of 1918 (124,621). C. and C. W. COCKER, Irvine, Scotland. Using a small amount of carbonate of soda in zinc distilling as flux.

9,855 of 1918 (123,912) and 20,597 of 1918 (123,960). W. & H. M. GOULDING, LTD., Dublin, and G. H. ALLIBON, Belfast. Improvements in the plant used in the manufacture of superphosphate.

9,882 of 1918 (124,646). R. P. PARK, Melbourne. A grinding mill containing a number of conical rollers pressing on a circular track, which is revolved, the rollers being revolved on their axes but not travelling round the table.

9,962 of 1918 (124,125). P. J. GRIFFIN, Toronto, Canada. Method of strengthening the roofs of electric furnaces.

12,008 of 1918 (120,034). NORSK HYDRO-ELEKTRISK Co., Christiania. In the production of ammonia from cyanamide of lime, previously warming the water used in the reaction

13,873 of 1918 (120,550). J. P. A. LARSON and W. D. BERGMAN, Stockholm. Method of obtaining pure aluminium hydroxide from clays containing silica and iron.

17,579 of 1918 (124,683). H. C. HALL and ROLLS-ROYCE, LTD., Derby. In aluminium alloys containing small proportions of copper, nickel, and zinc, the addition of 1% or less of antimony, which has the effect of preventing the formation of pinholes and contraction cracks.

19,170 of 1918 (124,006). B. LEECH, Macclesfield, and HENRY & LEIGH SLATER, LTD., Manchester. Electrolytic production of tin, particularly of tin paste or sponge.

19,219 of 1918 (124,162). FULLERTON, HODGART, & BARCLAY, LTD., and W. MCGREGOR, Paisley. Improved inlet valves of air-compressors.

NEW BOOKS

Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine* 723, Salisbury House, London Wall, E.C 2.

Hydraulic and Placer Mining. By Eugene B. Wilson. Cloth, octavo, 420 pages, illustrated. Price 13s. 6d. net. New York: John Wiley & Sons; London: Chapman & Hall.

Chapter I., geology of placer deposits, placer prospecting. Chapter II., hydraulic, salt, culm mining, booming. Chapter III., development of placer mining. Chapter IV., riffles, undercurrents, dump. Chapter V., water supply and measure. Chapter VI., flow of water in pipes and canals. Chapter VII., hydraulic giants and elevators. Chapter VIII., placer mining investments, costs, clean-up, drifting and mining in Alaska. Chapter IX., mining in North Carolina, log washer, steam shovel and cableway mining. Chapter X., dredges, dry placers. Chapter XII., black sands. Chapter XIII., United States mine laws. Chapter XIV., Canadian Yukon laws. Chapter XV., information in hydraulics.

Hydraulic and placer mining is a big subject, big enough to be treated separately in several ways, first, from the purely technical engineering viewpoint, second, from the purely practical viewpoint, third, from the purely commercial viewpoint. Mr. Wilson has tried to do all three, and so the "Practical Treatise on Hydraulic Mining" by A. J. Bowie, written over twenty years ago, is still the best book on the subject.

There is a distinct demand for a book to be called "A Practical Treatise on Placer Mining" that will have the same relation to placer mining, that is, to dredging, drifting, and hydraulicking, as Bowie's book has to hydraulic mining. Such a book can only be written by some one who has had in these three branches of placer mining the same intimate experience that Bowie had through having been in actual charge of hydraulic operations. Further, he must have had the advantage of practical experience in gold placers in California, that marvel of placer deposits, Alaska, Russia, Australia, New Zealand, South America, as well as in tin placers in Asia, Malaya, Australasia, and West Africa. As Mr. Wilson points out in his preface, the hydraulic giant has been used for other operations than gold mining, as, for instance, stripping, although, curiously enough, he has not availed himself of the voluminous data of such and similar work at Panama and around Lake Superior.

In Chapter I. Mr. Wilson gives a definition: "Placer mining is defined as washing surface depositions for gold," which many engineers will not accept. Messrs. W. H. Radford and L. A. Decoto will probably recognize themselves as "W. H. Badford" and "L. A. Docoto," but when such typographical errors are observed in a book it makes one a little suspicious as to the correctness of the numerous formulæ given subsequently.

In Chapter II., Mr. Wilson gives a novel definition: "in view of the scope that the term covers, the suggestive term 'hydraulicking' is applied to gold mining, and the term 'hydraulic mining' is used to cover all materials mined by the use of water." This does not assist, for application of the general subject to the particular branch and of the particular term to the general subject surely does not make for clearness.

In Chapter III., the statement: "sluices should be at least 240 ft. long and set in as straight a line as possible, otherwise fine gold and mercury may pass through" will make the washers of cemented clayey gravels and the users of numerous undercurrents take notice and feel like rushing into discussion. Mr. Wilson devotes considerable space to the means of determining the dimensions and gradients for sluices and to "graphic hydraulics." It is doubtful if such data are as helpful as the seemingly thoughtless, though easily understandable, statement: "put your sluices on as steep grade as you can get, while leaving sufficient dumping ground, and have your sluice of such width that the water running through it has such depth as to cover a majority of the boulders ordinarily run through it." Properly laying out sluices for hydraulic mining is an exceedingly difficult problem which can only be solved satisfactorily by an experienced person. To suggest that it can be done by anyone else even with the assistance of text or hand-books is dangerous.

Chapter V. is devoted to water supply, and one finds: "flumes are probably cheaper to construct than ditches and their repair is less." "In building a flume, nothing smaller than $1\frac{1}{2}$ in. plank, tongued and grooved, should be used, and these joints should be white-leaded and well driven home." These statements are wrong.

Although the measurement of water is considered, the use of the current meter is not even mentioned, but the haphazard, primitive, and inaccurate method, using floats is described.

Chapter VII. is devoted to giants and hydraulic elevators, and one finds the statement: "under favourable conditions the cost of working elevators is 5 cents per cubic yard, which includes the hydraulicking." This is a very misleading statement, for such work usually costs from five to ten times as much. A new term is introduced to the reader in this chapter, the "miner's head," which is 150 cu. ft. per minute. It is doubtful if this term is needed or will supplant the term "second feet" now in general use.

Chapter VIII. is called "Exploiting Placers." Only one paragraph is devoted to so important a matter as the cost of hydraulicking. And the only details given are those for mining at North Bloomfield and La Grange in California, given in Bowie's book on page 279 for mines operated probably over 25 years ago and not having average conditions, as the sluice grade was very low and the banks only 20 to 80 ft. high. Such data are not only out of date but misleading as well.

Chapter IX. in continuation of Chapter VIII. devotes considerable space to the comparatively unimportant operations of North Carolina and to the almost always unsuccessful application of steam shovels and cableways, discarded years ago, but no warning is given to prospective users of such excavators. Nothing is said about the drag-line excavator, a machine which because of its greater mobility and radius of action is applicable under certain favourable conditions.

Chapter X. is devoted to gold dredging. Practically all the data are nearly 20 years old, and nothing is said as to operations of the large modern dredges now used. Data are given as to dipper dredges, when all that is necessary to be said is that they should never be used for gold dredging and they have been scrapped for years in California and Alaska. The suggestion that suction pump dredges—meaning centrifugal pump dredges—be used in conjunction with bucket dredges is quite amateurish.

Chapter XI. is devoted to traction dredges, which practically always fail.

Chapter XII. is devoted to black sands, the working of which for gold or platinum is a hazardous matter, and the author could have done a great service in pointing out this feature instead of devoting space to speculating upon their possible value as a source of iron ore.

Chapters XIII. and XIV., devoted respectively to United States mine laws and the mining regulations for the Canadian Yukon, give some useful data.

Chapter XV. consists principally of tables taken from the catalogues of machinery makers and forms a convenient record. There are no original tables, seemingly.

Mr. Wilson's book cannot be considered as a helpful addition to technical literature. Trautwine and Peele, particularly the latter, can better serve anyone desiring information concerning hydraulic and placer mining problems. H. J. P.

Mining Manual and Mining Year Book, 1919. By Walter R. Skinner. Cloth, octavo, 840 pages, with maps and plans. Price 20s. net. London: Walter R. Skinner and *The Financial Times*.

This is the 33rd volume of Skinner's indispensable Mining Manual, a book which gives details of all mining companies registered in England and of such companies registered in the Dominions and in other countries as are known in the London mining market. We regret that with the new volume the alphabetical index of secretaries has been discontinued.

How to Form a Company. By Herbert W. Jordan. Paper covers, 100 pages. Price 1s. 4d. London: Jordan & Sons, Ltd.

Quicksilver Resources of California. By Walter W. Bradley. Cloth, octavo, 400 pages, with many illustrations. This is Bulletin 78 of the California State Mining Bureau.

Centrifugal Pumps and Suction Dredgers. By E. W. Sargeant. Cloth, octavo, 190 pages, with many illustrations. Price 15s. net. London: Charles Griffin & Co., Ltd.

Two years ago we reviewed the first edition of this book, and are glad to find that it has been received with so much appreciation that a second edition has become necessary. Though intended primarily for the civil engineer, we have found it on a great many occasions helpful in connection with electric mine pumps and with pump dredges.

COMPANY REPORTS

Gopeng Consolidated.—This company was formed in 1912 as a consolidation of the Gopeng and New Gopeng, which had been operating alluvial tin properties in Perak, Federated Malay States, since 1892 and 1903 respectively. The object of the consolidation was to facilitate the financing of a scheme, conjointly with the Kinta Tin Mines, for bringing a new supply of water at higher pressure for use in hydraulicking, the water being obtained from the Kampar river. The control of the company is in Redruth; James Wickett is chairman, and Osborne & Chappel are the managers. The report for the year ended September 30 last shows that 1,976,950 cubic yards of ground was treated for a yield of 937 tons of tin concentrate. During the previous year the figures were 2,477,850 yards and 1,018 tons, the fall being due to less ground being treated in the Serdang section. The concentrate was sold for £161,180, as compared with £120,064 the year before, the increase being due to the temporarily high price of tin. The profit for the year was £135,010, out of which £75,855 has been distributed among shareholders, being at the rate of 3s. 10d. per £1 share. The sum of £14,274 has been written off profits to provide for the wasting of the company's assets, and £10,725 has also been written off share-premium and reserve accounts for the same reason. In addition £7,500 has been written off pipe-line and equipment accounts. Out of the remaining balance, provision will have to be made for excess profits duty.

Tekka-Taiping.—This company was formed in 1913 as a subsidiary of the Tekka, for the purpose of acquiring an alluvial tin property at Taiping, in the Larut district of Perak, Federated Malay States. The control is in Redruth; James Wickett is chairman, and Osborne & Chappel are the managers. Operations were started with a pump dredge, but a bucket dredge was subsequently installed. The report for the year ended October 31 last shows that 767,000 cubic yards of ground was treated, for a yield of 417 tons of tin concentrate. The tin sales realized £73,487, and the total income was £76,607. The working profit was £59,642. Out of the profit, £5,978 has been written off for depreciation of the dredge, and £12,999 has been distributed as dividend, being at the rate of 20%. A landslip bent the digging ladder, causing a delay of 33 days. The bucket capacity has been reduced from 12 to $10\frac{1}{2}$ cu. ft., with the result that the digging capacity is as good as before, while the wear is reduced and the consumption of fuel considerably curtailed.

Pengkalen.—This company was formed in 1907 by James Wickett, of Redruth, for the purpose of acquiring an alluvial tin property at Lahat, in the state of Perak, Federated Malay States. An electrically driven pump-dredge is employed, and electric power is sold to adjoining operators. The report for the year ended September 30 last shows that the output of tin concentrate was 97½ tons, selling for £15,507. Tribute yielded £7,538, and the sale of electric power £13,658. The total income was £35,575, and the profit £16,972, out of which £6,000 was written off for depreciation, and £6,000 was distributed as dividend, being at the rate of 5% on the 90,000 ordinary shares and 15% on the 10,000 preference shares. Dredging has been difficult lately, as, owing to the ground worked being close to the Kinta river, the amount of seepage water is considerable. In fact, in the rainy season it is impossible to work the ground. The demand for electric power is increasing and much more could be sold. The extension of the generating plant is therefore under consideration.

Rambutan.—This company belongs to the Wickett group, of Redruth, and was formed in 1905 to work alluvial tin property in the northern part of the Kinta district of Perak, Federated Malay States. A pump dredge was used at first, but hydraulic elevating was substituted later. The report for the year ended June 30, 1918, shows that 505,700 cubic yards of ground was treated for a yield of 242 tons, selling for £38,259. The net profit was £29,327, out of which £13,333 has been paid as dividend, being at the rate of 2s. 8d. per £1 share. The sum of £2,110 was written off the cost of the pipe-line, and out of the balance provision will have to be made for excess profits duty. Additional ground of considerable promise has recently been acquired, and the pipe-line is to be extended to reach it.

Chendai Consolidated.—This company belongs to the Wickett group, of Redruth, and was formed in 1914 as a consolidation of the Redhills, Sungei Chendai, and the Chendai Lodes companies, working alluvial and lode tin mines in the Kinta district of Perak, Federated Malay States. The report for the year ended April 30, 1918, shows that, owing to scarcity of labour, operations were greatly restricted. At the Chendai Lode property 8,337 tons of ore was milled for a yield of 37 tons of tin concentrate. At the Katcha and Chendai alluvial properties, which are let on tribute, the yields were 17 and 91 tons respectively. The total output of concentrate was 143 tons. The company's income was £7,632, and the profit £1,188, out of which £950 has been employed in extinguishing the underwriting commission account. For the year previously there was an adverse balance of £130.

Brakpan Mines.—This company belongs to the Consolidated Mines Selection group, and was formed in 1903 to acquire from the Transvaal Coal Trust a number of gold claims on the farm Brakpan in the Far East Rand. Milling started in 1911, and the first dividend was for the year 1912. The report for 1918 shows that 712,900 tons of ore was raised, and after the removal of waste, 617,100 tons averaging 8·68 dwt. was sent to the mill. The yield of gold by amalgamation was 177,688 oz., and by cyaniding 80,584 oz., making a total of 258,272 oz., worth £1,089,959, being 8·37 dwt. or 35s. 4d. per ton milled. The working cost was £723,948, or 25s. 5d. per ton, leaving a working profit of £366,010, or 11s. 10d. per ton. The dividends absorbed £257,107, being at the rate of 32½%. As compared with the previous year, the yield was 10d. higher and the working cost 3s. 2d. higher, while the working profit was £116,000 less, and the dividend £110,413 less. Developments during the year did not fully maintain the reserve, and, in addition, many low-grade blocks had to be eliminated from the estimate on account of the increase in working cost. The reserve at December 31 stood at 2,718,000 tons averaging 8.7 dwt., as compared with 3,268,000 tons averaging 9·2 dwt. the year before. Water troubles continue to interfere with shaft sinking in the new area, and the cementation process has been applied for the purpose of decreasing the flow.

Springs Mines.—This company belongs to the Consolidated Mines Selection group, and was formed in 1909 to acquire from the Transvaal Coal Trust a number of gold claims on the farm Rietfontein No. 4 in the Far East Rand. Milling commenced in 1917. Additional ground was recently acquired on Government lease. The report for 1918 shows that 526,548 tons of ore was raised, and after the removal of waste, 427,610 tons averaging 10·76 dwt. was sent to the mill. The yield by amalgamation was 92,610 oz., and by cyaniding 122,705 oz., making a total of 215,315 oz., worth £905,777, being 10·07 dwt. or 42s. 4d. per ton milled. The working cost was £482,081, or 22s. 6d. per ton, leaving a working profit of £423,695, or 19s. 10d. per ton. Out of the profits £85,759 was written off development suspense account, and £62,343 was paid as tax and Government share in the profits. The shareholders received £144,187, being at the rate of 12½%, and in addition received a dividend in the form of shares in West Springs, at the rate of one share for every 10 held in Springs Mines, representing £115,000. The expenditure on shaft-sinking and equipment during the year was £189,671. As compared with the previous year, the yield per ton was 3s. 4d. higher, while the working cost was only 5d. higher. No. 3 shaft, in the new area, has passed through the dolomite without encountering any undue water-flow. The ore reserve at December 31 was estimated at 2,368,000 tons averaging 9·3 dwt., as compared with 2,567,000 tons averaging 9·8 dwt. the year before. The decrease in tonnage and value is due to ore in the North Shaft section proving of lower grade than originally estimated, and its consequent elimination.

City & Suburban.—This company was formed in 1887 under Natal laws to acquire an outcrop property in the central Rand. Of late years the technical control has been with the Central Mining group. Excellent dividends have been paid regularly until a year ago, but the mine is now nearing its end. The report for the year 1918 shows that 282,568 tons of ore was raised, and after the rejection of 12% waste, 248,730 tons, averaging 8·44 dwt. gold per ton, was sent to the mill. The yield by amalgamation was 68,969 oz., and by cyanide 31,342 oz., making a total of 100,311 oz., worth £416,922, or 33s. 6d. per ton milled. The working cost was £369,516, or 29s. 8d. per ton, leaving a working profit of £47,406, or 3s. 10d. per ton. The shareholders received a dividend of £25,500, being at the rate of 1s. 6d. per £4 share. The amount of ore milled was 57,720 tons less than in 1917, the yield per ton was 10d. less, and the working profit was £112,065 less. This comparatively unfavourable result was due to several causes, of which flooding of the lower levels, the partial crushing of the shaft pillars, and the scarcity of labour may be mentioned. The reserve at December 31 was calculated at 348,200 tons averaging 7·6 dwt., a fall of 163,700 tons during the year. More recent developments have proved the existence of further supplies of ore of fair quality. At the present time the deliveries of ore are so restricted, owing chiefly to scarcity of labour, that only 80 of the 150 stamps are working. The future of the mine is uncertain.

New Heriot.—This company was formed in 1887 under Natal laws to acquire a small property on the outcrop in the central Rand, and the control is in the same hands as the City & Suburban. The mine was continuously profitable for many years, but the ore is nearly exhausted and reclamation of ore in the upper levels is difficult. The report for 1918 shows that 170,836 tons was raised, and after the removal of 19% waste, 137,500 tons, averaging 6·88 dwt. gold per ton, was sent to the mill. The yield by amalgamation was 31,131 oz., and by cyanide 14,478 oz., making a total of 45,609 oz., worth £189,728, or 27s. 7d. per ton milled. The working cost was £190,294, or 27s. 8d. per ton, so that the balance was on the wrong side. As compared with 1917, the ore milled was 37,000 tons less, and the yield per ton was 5s. 4d. lower. Thus the total yield was £67,000 less, while the working cost showed a rise of £6,785. The increase in the cost was chiefly due to difficult development work required in order to make it possible to mine ore left behind in the upper workings. The decreased output of ore was chiefly due to flooding of the levels during the abnormal rains at the beginning of the year. The ore reserve is estimated at 223,420 tons, averaging 7·12 dwt., a fall of 111,560 tons as compared with the previous year. In addition there are a number of pillars calculated to contain 90,000 tons averaging 6 dwt. per ton.

Princess Estate.—This company was formed in 1888 to acquire property in the western Rand, and in 1911 the property of adjoining companies was absorbed. Dividends were paid in 1897 and 1899, and from 1908 to 1911. A year ago additional capital was raised in order to continue sinking and to provide new equipment. The control is with the Goerz group, now the Union Corporation. The report for 1918 shows that 243,046 tons was raised, and after the rejection of waste, 222,430 tons, averaging 6·26 dwt. gold per ton, was sent to the mill. The yield by amalgamation was 54,912 oz., and by cyanide 13,598 oz., making a total of 68,510 oz., worth £290,192, or 26s. 1d. per ton milled. The working cost was £322,841, or 29s. per ton, so that a loss was incurred of £32,649, or 2s. 11d. per ton. This loss was due chiefly to less ore being raised owing to shortage of labour and to underground rearrangements in connection with the plan for deeper sinking. For the same reason developments have been less than usual. The ore reserve is calculated at 380,000 tons averaging 7·2 dwt., as compared with 503,000 tons averaging 7·1 dwt. the year before. Since the turn of the year labour has been more plentiful and the rate of output of ore has increased.

Dundee Coal.—This company was formed in 1889 under Natal laws to work coal deposits in northern Natal. In 1913 the properties of the St. George's Coal Co. were absorbed. The report for 1918 shows that 336,537 tons of coal was raised. During the year coke manufacture was started, with 28 beehive ovens at St. George's, and 26 at Burnside, and the output was 8,288 tons. The income from the sales of coal and coke was £453,495, and the profit was £96,015, out of which £30,700 has been paid as dividend at the rate of 20%, £20,897 has been written off for depreciation, and £40,000 placed to reserve.

Kaduna.—This company was formed in 1910 to acquire alluvial tin properties in Nigeria. The first properties to be investigated were in the Kano district, but subsequently properties in the Arim district, 16 miles south-west of Bukeru, were acquired. Production started in 1912. Lake & Currie are the consulting engineers, and J. E. Snelus is manager. The report for the year ended October 31 shows that 179¾ tons of tin concentrate was recovered. If it had not been for the scarcity of native labour, the output would have been greater. The accounts show sales bringing in £43,908, and a profit of £14,043, out of which £8,340 has been paid as dividend, being 60% on the capital issued, £13,900. The general reserve account stands at £13,964, and it is now proposed to capitalize £13,900 of this by the issue of new shares at par. During the year part of the company's ground has been handed over to a subsidiary formed for the purpose, the Kaduna Prospectors, Limited. This company will examine and develop the property.

Wolfram Mining & Smelting.—This company was formed in 1909 to acquire the Penasqueira wolfram mines in the province of Beira Baixa, Portugal, the vendor being a Dutch firm. The present report covers the two years ended September 30, 1917, and September 30, 1918, respectively. During the first year the sales of wolfram were £32,446 and the profit £4,194, and during the second £50,126 and £16,606 respectively. Great difficulties were experienced in despatching concentrate to England during the war. Eventually it was decided to sell to French buyers, but owing to local official disputes as to prices the sales were hampered. Since the close of the war the ore has been taken in very small quantities. The directors consider it advisable not to distribute any dividend while the market is so uncertain.

Tharsis Sulphur and Copper.—This company was formed in 1866 to work pyrites mines in the south of Spain. Its headquarters are in Glasgow, and it has several metal works in this country where copper is extracted from the burnt pyrites. The report for 1918 shows that 328,601 tons of ore was raised from the Calanas mine, and that the output of refined copper was 3,246 tons. The net profit for the year was £126,295, out of which £125,000 has been distributed as dividend, being at the rate of 10%.

Mason & Barry.—This company operates the San Domingos sulphur and copper mine at Mertola, Portugal, and was formed in 1858. The report for 1918 shows that the exports of ore have been greatly restricted by shortage of shipping. The amount of ore raised was 80,079 tons, as against 154,762 tons in 1917, and 193,127 tons in 1916, and the shipments were 35,490 tons as compared with 43,529 tons and 202,176 tons. The profit for the year was £772. For the first time, the company finds itself unable to pay a dividend. The position has not improved since the turn of the year and shipping is still scarce. The company has also been troubled by adverse mining conditions, among other things an underground fire and bad ventilation, but the directors do not see any reason to anticipate difficulty in restoring the old rate of output, and only the inability to deliver pyrites restricts the business of the company.

Mazapil Copper.—This company was formed in 1891 to acquire copper mines in the state of Zacatecas, Mexico. The office is in Manchester. J. F. Allan is consulting engineer, and R. H. Jeffrey is manager. Copper, lead, gold, and silver are produced. The company has two smelting plants, the products of which are lead bullion and copper matte. Operations were suspended from 1913 to 1917 owing to the revolution. The report for the year 1918 contains no particulars of output, but mentions that the net profit was £26,614, which, added to the balance brought forward from 1917, made a disposable profit of £42,927. Out of this, £31,686 has been distributed as dividend, being at the rate of 7½%. Owing to the fall in the price of copper, the present position is uncertain, and the production of copper matte shows little or no profit.

EAST POOL & AGAR, LIMITED.

Directors: H. Montague Rogers (*Chairman*), J. C. Gardner, J. M Holman, W J. Loring, C. Algernon Moreing. *General Managers:* Bewick, Moreing & Co. *Secretary:* J F. Maynard *Office:* The Mine, Carn Brea, Cornwall. *Formed* 1913. *Capital:* £120.000 in shares of 5s. each.
Business: Works a tin-wolfram-arsenic mine between Camborne and Redruth.

The sixth ordinary general meeting of East Pool & Agar, Ltd., was held at the mine, Carn Brea, Cornwall, on April 16, Mr. H. Montague Rogers (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report for the year 1918, said that the company's receipts had risen from £178,710 for 1917 to £294,890 for 1918. The profits last year were £103,784, and in 1917 £59,651. The expenditure was proportionately increased, and prices of coals and materials had bounded up. In 1917 pumping charges were £14,388, and in 1918 £19,047. Labour costs had also increased; in 1913, 551 employees received £37,000, and in 1918, 520 employees received £63,997. Comparing 1914 and 1918, there was an increase of 81% per employee, and contract men were increased to 120%. The principal expenditure had been in mine developments, etc., £27,672; underground working, £63,211; treatment on surface, £43,112; and dues, £7,126. Sales of tin, 1,250 tons, had reached £249,543, giving an average of £194. 18s. 6d., against 943½ tons and £129,263 in 1917. Tin was their main product, and they sold 336½ tons more than in the previous year, the output for which realized £120,280 less. Wolfram was produced at slightly less price, while there was less arsenic, with an increased price of £3 per ton. Out of the balance available the directors proposed, instead of a cash dividend, to capitalize £30,000, increasing the capital of the company to £150,000 by the creation of 120,000 new shares of 5s., which would be forthwith distributed among the shareholders in the proportion of one fully-paid share to every four shares held. The reserve account had been increased to £20,000, which was thought ample to provide for excess profits duty and other contingencies. Their liquid assets amounted to £137,859, against £99,512 for 1917, £43,525 for 1916, and £19,224 for 1915.

During the year two new companies had been formed, which would be a credit to the industry: Tehidy Minerals, Ltd., and Tolgus Mines, Ltd. The former comprised a vast area and there were immense possibilities connected with it. The future of these concerns depended entirely on the price of minerals. Tolgus was an offshoot of East Pool. Their lodes were chasing straight into Tolgus, and they proposed to drive through the Agar section of East Pool into that place. He believed there were great possibilities in the future, and one could look with longing eyes towards Tolgus. During the year pumping had caused a great deal of anxiety, but thanks to the energy and skill of the management they were not going to be washed out, as was rumoured. They had installed electric pumps, and the top section was working; the second section would be installed by the end of the week. There was now no need for anxiety.

It was the duty of all connected with Cornish mining to do all they could in research work. For some time past tests had been made by Mr. A. Richards for chloridizing tin oxide. The Government badly wanted realgar and did not know where to get it. Government research scientists visited the mine, and in collaboration with Mr. Taylor and his staff experimented and completed the high-class product required. If Mr. Richards' furnace had not been in existence realgar would not have been furnished by East Pool. There was another scheme on foot for the refining of the arsenic produced. The old flues were to be abolished and the arsenic soot handled, which would oust the middleman.

Mr. C. Algernon Moreing seconded the motion. He said during the past few years he had been able to report that the attendance of the workmen had shown a great improvement. It was now with pleasure that he was able to state a further improvement in this respect. During 1918 they were able to maintain their output despite the large demands made upon their labour on account of the war. In 1913 lost shifts amounted to 14% and in 1918 to 4·3%. The reduction was very large and was of extreme importance in the efficient working of the mine. The workmen were to be congratulated upon responding to the directors' endeavours to bring about such an improvement. Much credit was also due to the local management of the mine. Every effort was being made by the directors to improve working conditions and also by the Joint Industrial Council of the Tin Mining Industry, and he saw no reason why the good feeling now existing on the mine should not continue to improve. Very little main driving or rising was done on the Rogers lode. It must be apparent that the development of the Rogers lode had fallen back during the year and had not kept pace with the extraction of ore on that lode. This was, of course, anticipated, but he had no wish to alarm them, because the main development had been carried far ahead of normal requirements by the time they started drawing heavily on the lode, but as soon as possible the development would be resumed. The reason for curtailing the work last year was solely a shortage of efficient labour, which not only prevented them having the usual amount of ground developed but also seriously hampered increasing the output of black tin to the fullest degree. Had more labour been available there was no doubt they could have increased the output to a much greater extent. As extra labour was not available it was necessary to withdraw most of the miners from the main development and place them on intermediate work. In the face of these adverse conditions they were able to increase the output of black tin from 943 tons in 1917 to 1,280 tons last year, an increase of 35%, which, in view of the circumstances, was extremely satisfactory. Further diamond-drilling was carried on with satisfactory results and the cost per foot was reduced from 11s. 7d. in 1917 to 8s. 3d. in 1918. It was intended to make certain additions to the concentrating plant, and plans had been prepared, but unfortunately the necessary work for carrying this into effect could not be secured. This additional plant was for the purpose of reducing the value of the tailings from the mill. While the percentage of extraction had been maintained the value of the tailings had increased on account of the higher-grade ore treated. They were hopeful that the additional plant when installed would effect an appreciable saving. No work was done in the new compartment of East Pool shaft, as the men previously engaged at that place had to be employed on work in connection with the new electric pump plant.

The motion to adopt the report and accounts was carried unanimously.

SOUTH CROFTY, LIMITED.

Directors: Francis Allen (*Chairman*), H. J. Meyerstein, Colonel H. A. Micklem. *Secretary*: T. Wallace Evans. *Office*: 6, Broad Street Place, London, E.C. 2. *Formed* 1906. *Capital*: £50,000 in shares of 5s. each.
Business: Works a tin-wolfram-arsenic mine between Camborne and Redruth.

The thirteenth ordinary general meeting of South Crofty, Ltd., was held on April 16 at Winchester House, London, E.C., Mr. Francis Allen (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for 1918, said the year had been one of unexampled prosperity in the affairs of the company. The board had dealt with the profit in a way he believed was right on behalf of the shareholders. They had increased their income-tax reserve account, and had carried forward a balance of nearly £28,000, but out of that they had to provide for excess profits duty. It was at first expected that the amount for excess profits duty would range from £17,000 to £19,000, but since that meeting their auditors had informed them that they could look forward to a very substantial reduction in that amount. The most material point they had to consider was in regard to the capitalization of the reserve, and he was glad to say that in regard to that they were a unanimous board, and they had the authority of their auditors that it was a prudent thing to do. In doubling their capital shareholders might take the view that it practically watered their stock and reduced the value of their present holding, but the board hoped that in the days to come they might pull the company to a point of prosperity when the shares which would be issued by way of bonus shares might become of the value at which the shares were at present. Though they capitalized their reserve with the exception of £3,000 or £4,000, the reserve would disappear from the account next year. They did not propose to add further to the reserves this year.

Mr. H. J. Meyerstein seconded the resolution.

Mr. Josiah Paull, the Manager, said the past year had been the most successful financially in the history of the mine, and excellent prices generally were received. The working cost at just under 35s. sounded high, but it compared favourably with other Cornish mines. As a whole, the development work for the past year had not been very successful, the chief point being the drive east of the 225 fm. level cross-cut north of Robinson's. That drive was on a lode which with regard to position corresponded to the Rogers lode in East Pool mine. He was strongly of opinion that the lode on which they were driving was not the Rogers, but a small south dipper which had interfered with or faulted with Rogers. Certain development they had carried out to the north of their main workings between Robinson's and Palmer's shafts had materially added to their ore reserves. As regarded the Castle-an-Dinas mine, that so far had come up to his expectations and was a virgin proposition. The Cornish mines had been badly hit during the past few months by the slump in tin and arsenic, but if the price of coal and materials would also go down things would not be so bad. He could not believe that this state of affairs would last indefinitely, but in the meantime they could not expect to get much profit from the mines in Cornwall. Though the present period through which they were passing was a lean one, there were just as good times ahead of South Crofty as those passed through in recent years.

The report and accounts were unanimously adopted.

The Chairman said they now came to a resolution which he might call the commencement of a controversial matter. When the question came before the board, Mr. Meyerstein had been asked by shareholders whom they looked upon as serious men of business whether it would not be wise, instead of going into further business of the Castle-an-Dinas nature, to spread their interest into other countries. Colonel Micklem did not see his way to fall in with that view, and, in fact, strongly objected to it. Accordingly, he, the Chairman, suggested that it should be left to the shareholders to decide, with a view to avoiding anything like a public controversy. He wished to point out that it was not true, as many people thought, that the tendency in Cornwall was to remain there as far as investments were concerned. As a matter of fact, those interested in Cornish mining had taken up investments in the Malay States and Nigeria, but unfortunately they formed new companies in order to do so, or otherwise the old companies would have been in a state of greater prosperity to-day. As was stated in the circular, they had absolutely nothing whatever in their minds and no proposition in view, but simply wished to test the views of the shareholders, so that if Mr. Paull became aware of any promising investment they would be at liberty to take it up. They certainly would not take up any investment unless it met with Mr. Paull's approbation. He pointed out that they had a splendid staff on the technical side to carry through anything of that kind. They had made a successful investment in Castle-an-Dinas and had never had cause to regret it. They did this out of current money, and they thought they might make similarly good investments abroad. He concluded by proposing: "That the directors be authorized to acquire and work or take an interest in any mining undertaking in any part of the world."

Mr. H. J. Meyerstein seconded the resolution.

Colonel Micklem said that the vital issue before the meeting was whether the company should acquire and work mining undertakings abroad. The company was formed for the express purpose of working a particular mine in Cornwall. The staff, including their highly qualified manager, was the staff required to carry on their operations in Cornwall, and no more. The working capital and reserve, weakened already by the purchase of Castle-an-Dinas, should not be withdrawn from South Crofty just at the time when, owing to the uncertain general outlook, the importance of being well supplied with funds was at its greatest, nor should their manager be withdrawn from the mine at the time his presence was most needed. Both courses would be disastrous to South Crofty.

The Chairman said that proxies had been received as follows:—On Colonel Micklem's side, 59 shareholders, holding 28,845 shares; and on the other side, 288 shareholders, holding 116,184 shares.

The resolution was then put to the meeting and was carried, 33 voting for it and Colonel Micklem against.

Colonel Micklem demanded a poll, but subsequently withdrew his demand.

THARSIS SULPHUR & COPPER CO., LTD.

Directors : Lord Glenconner (*Chairman*), W. P. Rutherford Jr. (*Managing Director*), Sir H. E. Maxwell, S. C. Hogarth, L. O. Schmidt, R. Millet, A. J. J. Messéan, F. A. Ducoing, Hugh Brown. *Secretary :* George Reid. *Office :* 136, West George Street, Glasgow. *Formed* 1866. *Capital :* £1,250,000.

Business : Operates pyrites mines in the south of Spain.

The annual ordinary general meeting of the Tharsis Sulphur and Copper Company, Ltd., was held on April 30 in the offices of the company, 136, West George Street, Glasgow, Lord Glenconner (Chairman of the company) presiding.

The Chairman said : The report and statement of accounts have been in your hands for some days, and I propose that we take them as read. Our balance sheet, I think you will agree, requires little comment from me. It shows our mines, railways, machinery, and plant at very low written down values as a result of the conservative policy which we have always followed. The item "Stocks in trade in Spain, including preparatory works," now stands at £816,302. This includes the amounts spent in removing overburden from the various open-cuts, which will be written down, as usual, by a fixed charge per ton of ore as it is mined. Although our Calanas mine alone can regularly supply more ore than we have shipped during recent years, we have considered it advisable to continue uninterruptedly the programme of development of the Sierra Bullones and North Lode open-cuts at Tharsis which we had mapped out before the war.

During the whole of last year the importation of pyrites into this country and its sale to the various users was under the control of a Government department. Generally, Tharsis ore has been supplied to those who were accustomed to use it in the past, and this company has acted as agents for Government in its shipment and distribution. Under these circumstances there has, fortunately, been little dislocation of our business in the United Kingdom. This control ceases at the end of May, and we have now started importation on our own account as before. Due to the United States Government restriction on the importation of pyrites to that country and to the closing of other markets, all due mainly to the scarcity of tonnage, our export of ore from Huelva has been much reduced and still continues at a low rate. Calanas mine supplied all the ore required, and the development of this mine continues in the most satisfactory manner. The food control which we have instituted in Spain, and to which I referred last year, is still in force and has been a great boon to the workpeople and their families. At our four works in this country operations have been carried on without interruption and our products have found a ready market. Our costs, however, have been very greatly increased, although we are constantly introducing improvements with the object of reducing them. Under existing circumstances, however, the acquiring and erecting of new plant is a very slow and tedious business. The extremely low rate of exchange with Spain has operated heavily against us and would have proved a most serious loss but for the fact that we were able to borrow a considerable proportion of our requirements in Spanish money. We do not require to repay this for some considerable time, when we hope the exchange will have further improved in our favour. The increased price of coal and stores of every description has been a heavy charge on our operating costs, especially so at our mines, and I think that, considering the many adverse factors which we have had to face, we are fortunate in being able to recommend to-day a dividend of 10%, free of income tax, which, may I remind you, is equal to 14% less tax.

With regard to prospects, the future is very uncertain. Copper is one of the few commodities which has fallen heavily in price since the Armistice. At that date we were getting £135 a ton for our brand ; to-day the price is £80, a figure which must be unprofitable for many mines. The prices obtainable for the sulphur in pyrites generally do not under the present circumstances yield a return commensurate with the high costs, due largely to high freights. This question of freight is one that affects us at every turn, because every ton of our ore is shipped and even our sales in Spain are delivered by coasting steamers. Stores for the mines are affected by the same cause, making the price, especially for coal, very high by the time it is delivered out there. Taking a longer view, I have every confidence in our position. We have enormous quantities of ore and are prepared for a large production when the demand arrives. The mines are equipped with the most modern plants, and we are constantly striving for still greater efficiency and economy in working in all departments. The staff at home and in Spain have had another strenuous year and are deserving of our appreciation. The duties of works officials have been exceptionally trying, and in Spain most members of the British staff have been at their posts for five years without a change. Before concluding I wish to express the pleasure I have in welcoming MM. Messéan and Ducoing, who have come over from Paris to be with us here to-day. With these remarks I beg to move : "That the statement of accounts and balance sheet and the reports of the directors and auditors thereon for the year ended December 31, 1918, be and the same are hereby received, approved and adopted ; that a dividend of 4s. per share, equal to 10% on the capital of the company, free of income tax, be now sanctioned and declared, payable on and after Friday, the 9th day of May next ; and that the balance of £29,034. 16s. 6d. be carried forward to the credit of the year 1919."

Mr. A. J. Messéan (Paris) seconded.

The Chairman invited questions, but none were asked and the motion was carried unanimously.

The Chairman : I shall now move the re-election of the retiring directors, the Right Hon. Sir Herbert Maxwell, Bart., Mr. S. Crawford Hogarth and Mons. Louis Oscar Schmidt.

Mr. F. A. Ducoing (Paris) formally seconded and the motion was unanimously adopted.

Mr. R. G. Maclennan (Glasgow) : I have much pleasure in moving that Mr. Alexander Moore, C.A., Glasgow, and Mr. Robert Campbell Mackenzie, C.A., Glasgow, be paid the sum of 300 guineas for auditing the books and accounts of the company for the past year, the amount to be equally divided, and that they be re-elected auditors of the company for the current year.

Mr. J. L. McCallum (Glasgow) seconded and the motion was unanimously adopted.

The Chairman : That, gentlemen, concludes the business.

GOPENG CONSOLIDATED, LIMITED.

Directors: James Wickett (*Chairman*), F. Douglas Osborne (*Vice-Chairman*), W. R. H. Chappel, Martin Edwards, S. Howard Lanyon, Cuthbert J. Pike, R. H. Savory. *Managers*: Osborne & Chappel. *Secretary*: Tom Wickett. *Office*: Redruth. *Formed* 1912. *Capital issued*: £395,768.

Business: Operates alluvial tin property in Perak, Federated Malay States.

The sixth ordinary general meeting of Gopeng Consolidated, Ltd., was held at Redruth, on May 7, Mr. James Wickett (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended September 30 last, said that the statement was probably the most satisfactory that had ever been issued by the company. There was a profit of £135,000, but even that did not show the exact state of things. They had a peculiar way of doing things in the East. The company paid a tax to the Government of £30,000 a year, which amount never passed through the books, as it was collected from the tin smelters and the company merely credited in their accounts the money they actually received. The tin had been returned at a wonderfully cheap rate. The actual cost of returning tin on the spot was £35 1s. 4d. per ton, which left a profit of £136 per ton, so that they had room for a further drop without it materially interfering with their profits. It was satisfactory that in the coming year excess profits tax would not be such a serious item as formerly. They would probably have to pay at least £30,000 excess profits, a rather serious matter. What they paid the States Government amounted to 15% on the gross returns, but there the Government was the landlord. It owned the country which it had opened up in a splendid way. There was no doubt that though the taxes were heavy the States constituted a very good country for investment.

Mr. F. Douglas Osborne seconded. He said that it had generally been his custom at the annual gathering to review the operations at the mine. That was all very well in times when he was in close contact with what was going on in the mine, but during the war he had not been able to follow things as closely as before, and he really had no more information to give than was embodied in the report. He had had no private advices, and, if he had a large fund of information to give about the mine, he should not do it, because all he had ever said to shareholders seemed to have been collected by the authorities at Somerset House, and every point he had made at the meetings had risen as a spectre when there was some question about excess profits duty, and had been thrown back. He therefore left the mine to take care of itself. They had the report of the managers, which dealt fully with everything that had happened, and let them take it that in this case silence was golden. He should like to refer to one point, and that was the attitude of the Government of the Federated Malay States toward this and other companies. Complaint had been made in the past that the Government charged a very high royalty on the tin produced. He had endeavoured to explain on former occasions that this capital had been used for the development of the country in facilitating their means of communication and cheapening transport, which had been of direct benefit to all the operating mines. The Government had always had the mining interests of the country in their care, and had done all that was possible to promote the industry, which was one of their chief sources of revenue. In the recent trying times the Government had nobly stepped into the gap. When the Armistice was signed there was a slump in tin, and the whole of the tin business was momentarily paralysed. Even at present there was no stability in it. There was no market in the Straits for their produce at the present time. There might be stacks of tin, but there was no one wanting to buy it even at a "give-away" price. As the mining industry in the country largely lived from hand to mouth, that was a very serious state of affairs. It would have meant the closing of the large majority of the Chinese-owned mines which were responsible for the greater proportion of the tin output of the Federated Malay States, but the Government stepped in and said they would undertake to buy all the tin that was produced at a fixed rate so long as there was no market. They had been doing that for some time in conjunction with the States Trading Co. In that way they had enabled the business to go along smoothly. They had done a great deal for the mines in return for what they had done for them, and not only had they come in as buyers, but as buyers in a very strong position. They had, moreover, assured the mining community through the Federated Malay States Chamber of Mines, that they had no intention of letting this tin go for less than they paid for it. Hence the mines had to thank the Government for the stability of the industry out there. He thought all that might have been said in the past as to the avarice of the Government in asking the mines to pay this large amount on the gross value might now be withdrawn, and they might recognize that the Government in their need had been a very real friend.

The motion was carried unanimously.

Mr. Ronald H. Savory, in proposing the thanks of the shareholders to Messrs. Osborne & Chappel, and their staff, for their efficient services during the year, and that a bonus of one month's salary be voted to the staff at the mines, said their Chairman had often stated the high opinion held in Cornwall of the ability and integrity of Messrs. Osborne & Chappel. An opinion no less high was entertained of these gentlemen in the City of London. There the most absolute confidence was felt in their word, and everything that they had done had been to the satisfaction of all concerned.

Mr. Martin Edwards, in seconding the motion, said they all knew they had a good property in Gopeng, but however good a property may be, unless it was well managed, the best results could not be obtained. They were greatly indebted to the management of Messrs. Osborne & Chappel for the return they had received upon their investment.

The motion was carried unanimously.

TEKKA-TAIPING, LIMITED.

Directors : James Wickett *(Chairman)*, J. W. Horton Bolitho, F. Douglas Osborne, J. Leonard Holman. *Managers :* Osborne & Chappel. *Secretary :* Tom Wickett. *Office :* Redruth. *Formed* 1913. *Capital issued :* £65,000.

Business : Operates alluvial tin property in Perak, Federated Malay States.

The fifth ordinary general meeting of Tekka-Taiping, Ltd., was held at Redruth, on May 7, Mr. James Wickett (Chairman of the company) presiding

The Chairman, in moving the adoption of the report and accounts for the year ended October 31 last, said that they had one of the grandest companies in the East, in regard to which they had been what might hitherto be called "playing at mining." When the way was clear they would work the mine on a scale commensurate with its merits and would make such returns as would surprise not only the shareholders, but the general public. The statement of accounts showed a profit of about £57,000, out of which they had divided the small sum of £13,000. The Government would probably have a big share of what was left. Still they knew that in the natural order of things the profits would be theirs, and when the excess profits duty was abolished, as he hoped it would be next year, they would present a statement that would make them smile. They had done moderately well this year. The cost of producing tin had been £45. 16s. 11d. per ton, and there was a profit of £145. 14s. 3d. It was, therefore, very clear that had they been able to work this property as some other properties were worked, a very different statement would have been produced. He was very pleased to be the Chairman of the coming mine of the Malay States, and was assured by people who knew something about mining, and who were in no way connected with their managers, that this was likely to be one of the finest properties in the Malay States.

Mr. F. Douglas Osborne seconded the motion. He said there was undoubtedly a great future for the company. In early course, the board would be able to lay before them a scheme for extending the mining operations. The mine had been crying out for some years for more attention. They had been unable to give it the attention it deserved owing to the impossibility of obtaining further machinery, and the fact that, if they had gone on working it on a large scale it would not have been worked for the benefit of the shareholders, but for that of others, and the directors did not think that that was a sound policy. It was better to work so as to allow the shareholders a little, rather than let other persons get a good deal. The extent of the property was large and they had only one small dredger upon it. It might be possible in course of time to erect at least three, if not four, units on it, the effect being to reduce working costs. The report stated that working costs were considerably higher than during the previous year. That was entirely due to the war, to which they attached blame for everything. Anyone would be rather optimistic if he forecasted costs would go down in the following year, or that they would ever go down; but they could reduce costs by adding to the units and carrying larger supplies and save in the way of wearing parts and material than when they were working on the present small scale.

The report was unanimously adopted.

PENGKALEN, LIMITED.

Directors : James Wickett *(Chairman)*, J. W. Horton Bolitho, S. M. Abbott, F. D Bain, Stanley Wickett *Managers :* Osborne & Chappel *Secretary :* Tom Wickett. *Office :* Redruth. *Formed* 1907. *Capital :* £10,000 in preference shares and £90,000 in ordinary shares.

Business : Operates alluvial tin property in Perak, Federated Malay States.

The eleventh ordinary general meeting of Pengkalen, Ltd., was held at Redruth, on May 7, Mr. James Wickett (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended September 30 last, said the profit disclosed was moderately satisfactory, about £17,000 on a capital of £100,000. They would notice not only sales of tin but sales of power. The amount paid in dividend was not a large one, but the profit for the year showed an increase, making, with the balance brought forward, £20,000, out of which dividends of 10% on the preference shares and 5% on the ordinary shares had been paid, and absorbed £6,000. The directors had decided to write off £6,000 for depreciation on machinery and plant, and to carry forward the balance of £8,874. The managers told them an area near the river had been bored and found to contain profitable ground sufficient to warrant the installation of an electrically operated bucket-dredge, a class of machine that had been remarkably successful in the East. It constituted a cheap means of working, and he hoped they might soon have the benefit of such an installation at Pengkalen. They had had a price for tin in the past year much higher than had prevailed for this, but he hoped they might have an increased quantity of tin so that at the end of the year they might be in a position to show as good a profit as they had done to-day.

Mr. J. W Horton Bolitho seconded the motion, which was carried unanimously.

Mr. F. Douglas Osborne proposed the next resolution, that the sum of £250 free of tax be voted to the directors for their services during the year. The position of the directors of the company was unusual. They worked for nothing unless they, at a general meeting, offered them something, and he did not think any of them were too proud to accept a little recognition for what they had done during the year.

Mr. Harry Rich seconded the motion, which was carried unanimously.

Mr. Fred D. Bain proposed that the best thanks of the shareholders be tendered to Messrs. Osborne & Chappel, and the staff, for their efficient services during the year, and that a bonus of one month's salary be voted to the staff at the mines. They had all noted the paragraph to which the Chairman called attention as to the possible installation of an electrically operated bucket-dredge at an early date. It would seem from the report that they must, in the natural order of things, expect lower returns from the present suction dredge, and also from tribute sources. It might not be long before Mr. Osborne and his partners would be able to advise them that the time had come when that electrically operated bucket-dredge should be ordered.

Mr. S. M. Abbott seconded the motion, and it was carried unanimously.

RAMBUTAN, LIMITED.

Directors : James Wickett (*Chairman*), E. Douglas Osborne, R. H. Savory, C. V. Thomas, Stanley Wickett. *Managers* : Osborne & Chappel. *Secretary* : Tom Wickett. *Office* : Redruth. *Formed* 1905. *Capital* : £100,000.

Business : Operates alluvial tin property in Perak, Federated Malay States.

The thirteenth ordinary general meeting of Rambutan, Ltd., was held at Redruth, on May 7, Mr. James Wickett (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended June 30 last, said that the profit, which was rather over £29,000, on the whole revealed a very satisfactory condition of things. If they looked on the other side of the balance sheet they would see that they had paid four dividends and had still a substantial balance in hand. They did not know yet what proportion of that the Government would take, but they would probably take a good share. There was one consolation, however, that in the future they would not take so much, and he hoped that, at the end of another year, they would have seen the last of the excess profits tax. The expenditure side of the accounts showed that they had invested, roughly, £32,000, and £6,000 in cash, so that the financial position was thoroughly sound. They had had a wonderful price for tin during the past year, and they might safely calculate on soon getting a better price than they had been receiving lately. Tin went higher than ever he anticipated it would do, but he hoped that in the natural course of trade they would at least have a price equal to £250 per ton. That would be fairly satisfactory so far as the mines of the East were concerned. If they looked at the figures sent home by the managers they would find that it had cost £41 per ton to return tin and this had left a very good margin of profit. In fact very few mines in the East could be worked as profitably as Rambutan, as it possessed the means of treating the ore very cheaply. The profits had not been wonderful, but the dividends paid had been satisfactory and he only hoped they might be able to do as well, or even better, in the future than they had done in the past. Rambutan was a fairly large property and there was no knowing when and where a good bunch of tin might be found. His experience of mines in the East had taught him that boring was not altogether very reliable, but in most instances the result of ordinary working had far exceeded the original estimate, which was certainly creditable to those who had been at the head of affairs on the spot. They could not in life always command success, and he had often noticed that when one took more care than usual the issue was not commensurate with the effort put forth. He hoped they would continue to have good dividends in Rambutan, and he was inclined to think they would. With anything like a satisfactory price for tin, he thought they might look forward to more prosperity in the future than they had had in the past.

Mr. C. V. Thomas seconded the motion, and it was carried unanimously.

JOS TIN AREA (NIGERIA), LTD.

Directors : H. T. Miller (*Chairman and Managing Director*), J. G. M. Brownjohn, C. D. A. Lever, A. T. Schmidt, L. N. Way. *Secretary* : W. Snoad Griffin. *Office* : 1 to 4 Giltspur Street, London, E.C.1. *Formed* 1910. *Capital issued* : £75,000 in shares of 5s. each.

Business : Operates alluvial tin properties in Nigeria.

The eighth ordinary general meeting of Jos Tin Area (Nigeria), Ltd., was held on April 23 at Winchester House, London, E.C., Mr. H. T. Miller (Chairman and managing director) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended July 31, 1918, said the profit for the year was £15,268. They had written off for development redemption £1,000, for dredge depreciation £2,000, and had placed to reserve account £2,000. They had paid a dividend of 10% together with a bonus of 2½%, altogether absorbing £9,375. The output for the year was 267 tons. They took advantage of the very high price of tin which was ruling during the period covered by the report to work some of the lower-grade ores, which would not be highly payable with tin at a lower figure. The development of the properties had been quite satisfactory. They had had one or two useful discoveries in the way of deep workings. These workings were found buried under perhaps 100 ft. or so of overburden. Undoubtedly the great future of Nigeria lay in these old river beds. These deep deposits were found very largely by accident and they were, as a rule, tested by means of drills. The old method of testing deposits by sinking pits was to a great extent becoming obsolete in Nigeria to-day. The labour position during the war was rather acute. At one time the supply of labour was very short indeed, but as the Government required tin they did their best to help the mines, and they enlisted labour from outside sources and distributed it over the various mining camps which were in need of it. In that way the position was considerably eased. The transport position during the period covered by the accounts was naturally very acute, but they were able to bring their tin along almost as rapidly as it was produced, and their losses at sea were very small. He desired to take this opportunity of saying a few words in appreciation of the services of the late Governor-General of Nigeria, Sir Frederick Lugard. This gentlemen was retiring after quite a number of years' service in Nigeria. He had done his level best to help the mining community, and not only the mining community, but the natives of Nigeria and the trade of Nigeria, and to open up that country in a sound way in every respect. As Britishers they had reason to be proud of the splendid service which Sir Frederick Lugard had put in for the Empire. He also desired to say how much they appreciated the work of the Nigerian civil officials. They had had a great deal to do with them during the last three or four years, with so much control, and they had had every reasonable help and consideration at their hands. He felt, too, that they had reason to be proud of the magnificent staff of Englishmen in Nigeria who were running that country and very largely ameliorating the conditions of the natives there.

Mr. L. N. Way seconded the motion, which was carried unanimously.

RAND SELECTION CORPORATION, LTD.

(*Incorporated in the Transvaal*.)

Directors : F. R. Lynch (***Chairman***), J. H. Gratton, H. S. Johnson Hall, W. E. Hudson, C. Marx, E. Oppenheimer, F. G. C. E. Robellaz, W. S. Saunders, G. Sonn. *Secretaries* : The Consolidated Mines Selection Company, Ltd. *Head Office* : Johannesburg. *London Office* : 5, London Wall Buildings, E.C.2. ***Formed*** in 1889 as the Transvaal Coal Trust, Ltd. ***Capital*** : £550,000.

Business : The finance and development of mining properties, particularly in the Far East Rand.

EXTRACTS FROM THE REPORT OF THE DIRECTORS FOR THE YEAR ENDED DECEMBER 31, 1918.
To be submitted at the 27th Ordinary General Meeting, to be held in Johannesburg, on May 23, 1919.

Particulars of the Brakpan Mines, Limited, and Springs Mines, Limited, are given in the reports of these companies.

At the Daggafontein Mines, the flooding of the mine workings prevented the continuation of development throughout the year, but progress was made with the sinking of the No. 2 Shaft. The water difficulties have now been overcome, and development work was resumed early in February. Preliminary steps in connection with the proclamation of the Farm Daggafontein have been taken, and in due course the location of the mynpacht will be decided upon. An application has been submitted to the Government for a grant of a lease of the undermining rights of an additional area of the ground contiguous to the mynpacht. The Corporation's undertaking to subscribe for 15,000 shares in Daggafontein Mines, Ltd., within two years from March 28, 1916, was completed during the year by the taking up of the balance of 2,500 shares. Under the agreement entered into with the Consolidated Mines Selection Company, Ltd., on April 11, 1916, the Corporation accepted a participation of 20% in the guarantee of a loan of up to £100,000, which was arranged in order to provide Daggafontein Mines, Ltd., with further funds, so that the operations of the company might be carried on without interruption. The loan bears interest at 1% above the Bank of England rate current from time to time, with a minimum of 6½%, and is to be repaid by March 31, 1919, from funds which will accrue to the company from the exercising of the options maturing on the 27th idem. The guarantors of the loan received a cash commission of 2½% and the right to call at par any shares which may not be taken up by the holders of the options above referred to.

At the end of the year the Corporation's interest in this concern was as follows: 71,276 fully paid shares of £1 each; options dating from March 28, 1916, on 11,906 shares at par for 3 years, 6,250 shares at 22s. 6d. for 4 years, 6,250 shares at 22s. for 5 years; 600 fully paid shares of £1 each in Daggafontein Gold Mining Company, Ltd. (in liquidation), which will be exchanged for 300 fully paid £1 shares in Daggafontein Mines, Ltd., and an option at par on 150 shares for three years from March 28, 1916.

As regards West Springs, in terms of the agreement of April 11, 1916, with the Consolidated Mines Selection Company, Ltd., the Corporation accepted a participation of 10% in the subscription of the capital of £1,400,000 of West Springs, Ltd., the company formed to work the Rietfontein West Lease Area of 2,236 claims, for which the tender of the Anglo-American Corporation of South Africa, Ltd., was accepted by the Union Government. After providing for the shares allotted to the public in South Africa and certain sub-participants, the *pro rata* subscription of the Corporation was 125,032 shares, of which 25,032 are fully paid up and 100,000 are 2s. paid up. Under the provisions of the Government Lease, the Corporation receives a commission at the rate of 5% as consideration for the guaranteeing of the subscription, such commission being payable on the amounts actually subscribed from time to time. A sum of £2,487. 7s. 2d. has been received, and a further sum of £4,500 will be received as and when the balance of 18s. per share on the partly-paid shares is subscribed. The Corporation's interest in West Springs, Ltd., was increased by 27,029 fully paid £1 shares, received from Springs Mines, Ltd., as a dividend upon its shareholding in that company, and options to take up 27,029 shares at 22s. 6d. each, issued by the Anglo-American Corporation of South Africa, Ltd., as consideration for working facilities afforded by Springs Mines, Ltd. In addition, 6,387 options will be received in respect of the guaranteed subscription of 63,875 shares in Springs Mines, Ltd., mentioned above. At the end of the year the Corporation's interests in West Springs, Ltd., had been reduced by sales to 37,751 shares fully paid, 100,000 shares 2s. paid, and an option to take up 24,913 shares at 22s. 6d. each during the period expiring on June 14, 1920, or one year after the Declaration of Peace between Great Britain and Germany, whichever date shall be the later.

Negotiations are proceeding with a view to the exchange of the New Geduld Deep Mynpatchen for an equal area on the Farm Daggafontein, under the provisions of Section 16 of the Transvaal Mining Leases and Mineral Law Amendment Act, 1918. If the negotiations are successful, it is the intention to sell the exchanged ground to Daggafontein Mines, Ltd., for a share consideration in the capital of that company, a provisional agreement to this effect having been entered into between Daggafontein Mines, Ltd., and the owners of the Mynpachten.

The unappropriated balance at the end of 1918 amounted to £86,361. 17s., arrived at as follows:

Dividends on Shareholdings and Schapenrust Claims Revenue				£144,906	[illegible]	11
Brakpan and Springs Townships				50,184	7	3
Owner's Share of Claim Licences........				7,093	17	8
Bewaarplaats Moneys, Farm Brakpan..				1,800	0	0
Net Profit realized from Sales of Shares etc.				9,012	0	2
Interest, Sundry Revenue, etc.				8,420	2	2
				£221,416	16	2
Deduct—						
General Charges and Contributions to War Relief Funds, etc. ..				12,891	0	8
Net Balance to Credit of Profit and Loss Account				£208,525	15	6
Add—						
Balance to Credit of Appropriation Account, December 31, 1917				75,04[illegible]	13	[illegible]
				£283,569	8	8
The following amounts have been appropriated:						
Government Taxes......	£4,707	11	8			
Dividends Nos. 37 & 38 45	192,500	0	0			
				197,207	11	8
Unappropriated Balance Dec. 31, 1918				£86,361	17	[illegible]

BRAKPAN MINES, LIMITED.

(*Incorporated in the Transvaal*)

Directors: F. R. Lynch (*Chairman*), W. E. Hudson, C. Marx, H. Newhouse, E. Oppenheimer, E. J. Renaud, W. S. Saunders. *Secretaries*: The Consolidated Mines Selection Company, Ltd. *Head Office*: Johannesburg. *London Office*: 5, London Wall Buildings, E.C. 2. *Formed* 1903. *Capital authorized*: £850,000.

Business: Operates a gold mine in the Far East Rand.

EXTRACTS FROM THE REPORT OF THE DIRECTORS FOR THE YEAR ENDED DECEMBER 31, 1918.

To be submitted at the Sixteenth Ordinary General Meeting of shareholders, to be held in Johannesburg, on May 23, 1919.

During the year the right to take up 5,000 shares at £5 each was exercised, thereby increasing the issued capital of the company to £791,100, in 791,100 shares of £1 each, fully paid. The balance of 58,900 shares remains to be issued in accordance with the provisions of the agreement with The Consolidated Mines Selection Company, Ltd., dated October 20, 1916. No change has taken place during the year in your Company's holdings.

The profit from operations for the year amounted to		£366,010 3 3
Deduct		
Additional War Charges on Gold Realization	£10,212 11 9	
War Relief Funds and Donations	2,883 2 7	
		13,095 14 4
		£352,914 8 11
Add Interest, Dividends on Shareholdings, Estate and Sundry Revenue		4,363 3 9
Leaving a Net Balance of Revenue over Expenditure for the year of		£357,277 12 8
Add Balance to Credit of Appropriation Account at December 31, 1917		35,395 3 5
Making a total available Credit of		£392,672 16 1

Against which the following amounts have been appropriated:

Government Taxes	£49,270 15 4	
Participation in Profits	16,723 15 7	
Dividends Nos. 13 and 14	257,107 10 0	
Development Suspense Account	18,338 10 8	
		341,440 11 7
Leaving a Balance unappropriated at December 31, 1918, of		£51,232 4 6

Capital Expenditure for the year amounted to £127,046. 9s. 2d., made up as follows:

Transfer and Stamp Duty, Schapenrust Claims	£3,313 9 3
Shaft Sinking and Equipment	123,383 6 11
Shares in other Concerns and Office Furniture	349 13 0
	£127,046 9 2

In terms of the agreement with The Consolidated Mines Selection Company, Ltd., in regard to the financing of the Lease Area, the commission payable to that company in connection with the guarantee of the loan of £250,000 fell due and was paid on January 1. The amount (£12,500) has been written off to premium on shares account. The expenditure on development for the year amounted to £120,735; of this amount £91,937 was charged to working costs, representing the fixed charge for the redemption of tonnage milled for the year. The net balance of £18,338, after deducting the credit balance of £10,459 carried forward under development suspense account at December 31, 1917, has been written off to appropriation account.

During the year the Provincial Gold Profits Tax Ordinance, 1918, was promulgated. This Ordinance provides for the levy by the Transvaal Provincial Council of a tax upon the profits derived from the production of gold. With a view to testing the validity of the Ordinance, legal action has been instituted by the gold mining industry, acting conjointly through the Transvaal Chamber of Mines. As the tax in the meantime constitutes a statutory liability, the estimated amount payable by the Company, £6,232, has been allowed for in the appropriation account.

Two dividends have been declared during the year:

No. 13 of 20%, absorbing	£158,220 0 0
No. 14 of 12½%, absorbing	98,887 10 0
	£257,107 10 0

EXTRACTS FROM THE CONSULTING ENGINEER'S REPORT.

During the year a total of 617,100 tons was milled, a decrease of 60,400 tons when compared with the previous year's crushing. The yield averaged 35s. 3·9d. per ton milled, working costs being 23s. 5·6d., leaving a profit of 11s. 10·3d. The yield was higher by 10d., working costs by 3s. 2·5d., the profit being lower by 2s. 4·5d. per ton when compared with the corresponding figures for the previous year. The outstanding feature was the heavy increase in working costs. War conditions accounted for the major portion of the rise in costs, but the development charge also showed an increase of about 1s. per ton milled. The working profit amounted to £366,010. Additional war charges in connection with gold realization involved £10,212, the net profit being £355,798, or £115,374 less than that obtained during 1917. The improved yield is accounted for by higher-grade ore being stoped from the ore reserve; the effect thereof upon the mill grade, however, was partially offset by a decreased percentage of ore derived from this source. The epidemic of Spanish influenza which occurred during September seriously affected operations during the last quarter of the year. The ore crushed during that period was 21,000 tons below the average of the first three quarters of the year, the profit similarly showing a decrease of £35,500. During the year 15,741 ft. of development work was accomplished, of which 9,846 ft. were on reef averaging 9·10 dwt. over 38·95 in. The re-calculation of the payable ore reserve as at the end of the year shows 2,718,000 tons of an average assay value of 8·7 dwt. per ton over an average stoping width of 68 in. The estimated tonnage is lower by 550,000 tons and the assay value by 0·5 dwt. when compared with the corresponding figures as at the end of the previous year.

C. E. KNECHT.

SPRINGS MINES, LIMITED.

(*Incorporated in the Transvaal*.)

Directors: F. R. Lynch (*Chairman*), W. L. Honnold, W. E. Hudson, C. Marx, H. Newhouse, E. Oppenheimer, W. S. Saunders. *Secretaries:* The Consolidated Mines Selection Company, Ltd. *Head Office:* Johannesburg. *London Office:* 5, London Wall Buildings, E.C. 2. *Formed* 1909. *Capital authorized:* £1,500,000; debentures £138,380.

Business: Operates a gold mine in the Far East Rand.

EXTRACTS FROM THE REPORT OF THE DIRECTORS FOR THE YEAR ENDED DECEMBER 31, 1918.
To be submitted at the Tenth Ordinary General Meeting, to be held in Johannesburg on May 23, 1919.

In order to comply with the obligations in connection with the acquisition of the Lease Area, the registered capital of the company was increased at the beginning of the year under review by 300,000 shares of £1 each, making the total registered capital £1,300,000. The following ordinary £1 shares of the company have been issued at £3 per share:

103,250 shares, the proceeds to be applied to shaft sinking and preliminary development.

50,250 shares, the proceeds to be applied to redemption of debenture debt.

153,500 shares.

The capital of the company, therefore, is now as follows:

Authorized	£1,500,000
Registered	1,300,000
Issued	1,153,500

There remain 346,500 ordinary £1 shares to be taken up at £3 each by The Consolidated Mines Selection Company, Ltd.

The profit from operations for the year amounted to		£423,695 14 0
Deduct		
Additional War Charges on Gold Realization	£8,505 13 8	
War Relief Funds and Donations	1,444 2 8	
		9,949 16 4
		£413,745 17 8
Less		
Interest, Commission and Exchange, Interest on Debentures, after allowing for Dividends on Shareholdings, Profit on Sale of West Springs Shares, etc.		11,554 0 2
Leaving a Net Balance of Revenue over Expenditure of		£402,191 17 6
Add		
Balance to Credit of Appropriation Account, December 31, 1917		214,953 16 8
Making a total available Credit of		£617,145 13 9
Against which the following amounts have been appropriated:		
Government Taxes	£47,930 6 0	
Government Participation in Profits	14,413 8 0	
Dividends Nos. 1 and 2	259,187 10 0	
Development Suspense Account	85,759 0 9	
		407,290 4 9
Leaving a Balance unappropriated at December 31, 1918, of		£209,855 9 0

Capital Expenditure for the year amounted to £192,357 8s. 11d., made up as follows:

Cost of 20 Stands in Springs Township	£1,032 12 6
Shaft Sinking and Equipment	189,671 4 11
Shares in other Concerns	1,653 11 6
	£192,357 8 11

Two dividends have been declared during the year, namely:

No. 1 of One Share in West Springs, Ltd., for every Ten Shares held, on an Issued Capital of £1,150,000	£115,000 0 0
No. 2 of 12½% on an Issued Capital of £1,153,500	144,187 10 0
	£259,187 10 0

EXTRACTS FROM THE CONSULTING ENGINEER'S REPORT.

The extension of the reduction plant being completed early in the year enabled a substantially larger tonnage to be crushed, the total being 427,610 tons, as against 313,065 for the previous year. The yield averaged 42s. 4·4d. per ton milled, working costs being 22s. 6·6d., the profit 19s. 9·8d. When compared with the results for the previous year, the yield was higher by 3s. 4·4d., costs by 5·4d. and the profit by 2s. 11d. The higher yield was due to the absence of the adverse circumstances referred to in my previous annual report. The working profit totalled £423,696, the net profit, after deducting £8,506 additional war charges for gold realization, being £415,190. This is an increase of £156,479 over the previous year. The outbreak of Spanish influenza and the subsequent shortage of native labour seriously affected operations during the last quarter of the year. When compared with the previous quarter, the tonnage crushed showed a decrease of over 25,000 tons, while the profit was lower by about £27,000. Development work accomplished during the year totalled 17,890 ft., of which 12,899 ft. were on reef averaging 17·80 dwt. over 22·90 in. The payable ore reserve as at the end of the year was estimated at 2,368,000 tons of an average assay value of 9·3 dwt. per ton over an average stoping width of 61 in. Compared with the estimate at the end of the previous year, the tonnage is lower by 199,000 tons and the average assay value by 0·5 dwt. The estimated stoping width is greater by 3 in. The decrease in tonnage is due to the elimination from the payable reserve of a large tonnage, mostly in the North Shaft section of the mine, formerly regarded as payable, but which, as stoping progressed proved to be of a value below the present pay limit. In addition to the payable reserve, there stands in the mine 436,000 tons of an estimated average assay value of 4·13 dwt. over 52 in. stope width, a large proportion of which will probably be worked at a profit at a later date. The average yield of the present ore reserve is estimated at from 38s. to 42s. per ton milled, according to the proportion and value of ore to be derived from sources outside the payable reserve. The sinking plant for No. 3 Shaft was completed, and a total of 444 ft. was sunk, of which 383 ft. were timbered at the end of the year. The dolomite was passed through without difficulty, practically no water having been encountered, and the shaft is now being sunk in Witwatersrand quartzite.

C. E. KNIGHT.

WEST SPRINGS, LIMITED.

(Incorporated in the Transvaal)

Directors: E. Oppenheimer (*Chairman*), W. J. Honnold, F. R. Lynch, W. S. Saunders, Sir Evelyn Wallers. *Secretaries:* The Consolidated Mines Selection Company, Ltd. *Head Office:* Johannesburg. *London Office:* 5, London Wall Buildings, E.C. 2. *Formed* 1918. *Capital authorized:* £1,400,000.
Business: Operates a gold-mining property in the Far East Rand.

REPORT OF THE DIRECTORS FOR THE PERIOD ENDED DECEMBER 31, 1918.
To be submitted at the Second Ordinary General Meeting of shareholders, to be held in Johannesburg, on May 23, 1919.

The area leased by the company is 3,286·4 acres on Farm Rietfontein No. 14 = 2,235·65 claims.

The capital of the company remains unaltered, as follows:

400,000 shares of £1 each, fully paid up ...	£400,000
1,000,000 shares of £1 each, 2s. per share paid up	100,000
1,400,000	£500,000

The agreement defining the terms and conditions under which Springs Mines, Ltd., grant to this company mining facilities by allowing the use of certain shafts and levels in Springs Mines was duly drafted, and, after having been submitted to the Minister of Mines for his approval, was completed. A copy was forwarded to shareholders under circular dated October 10, 1918, together with copy of a letter from the Secretary for Mines and Industries signifying the approval of the Minister of Mines to the agreement. The working arrangements come to under the agreement became operative during the period under review.

Technical matters are dealt with in the reports of the consulting engineer and acting mine manager.

The cash receipts and expenditure from the inception of the company to December 31, 1918, were as follows:

RECEIPTS.

Capital Account		
400,000 shares of £1 each, fully paid	£400,000 0 0	
1,000,000 shares of £1 each, 2s. paid up	100,000 0 0	
		£500,000 0 0
Interest and Sundry Revenue ...		7,540 8 1
		£507,540 8 1

EXPENDITURE.

Mining Rights—Rental to December 31, 1918 ...	£4,006 3 4
Shaft Sinking, Permanent Haulage Ways and Equipment ...	68,631 [illegible]
Guarantor's Commission on Paid-up Capital ...	5,000 0
General Expenses	9,5[illegible] 1
Balance, being Cash and Cash Assets after deducting Sundry Creditors and Credit Balances	420,[illegible]6 1[illegible] 4
	£507,540 8 1

Under Clause 8 of the working agreement with Springs Mines, Ltd., the amount loaned at the end of the year was £1,630. 7s. 11d. This loan is shown separately in the balance sheet under the heading "Springs Mines, Ltd., Development Loan." The clause of the agreement lays down that during the time certain haulage ways and lateral drives are being extended in the Springs Mines area to enter this company's property, West Springs, Ltd., shall bear the cost of the extensions, which cost must be refunded by Springs Mines, Ltd., if and when the haulage ways and drives are utilized by that company in connection with stoping operations, but in any case by September 29, 1923.

Article 97 of the company's articles of association provides that at each ordinary meeting held after the end of the year 1922 two of the directors shall retire from office.

You are requested to fix the remuneration for the past audit, and to appoint auditors for the ensuing year.

Mr. Alex. Aiken and Messrs. Deloitte, Plender, Griffiths, Annan & Co. retire, but are eligible and offer themselves for re-election.

E. OPPENHEIMER, *Chairman*,
J. H. GRATTON,
F. R. LYNCH,
W. S. SAUNDERS,
E. A. WALLERS,
} *Directors.*

The Consolidated Mines Selection Company, Ltd. (Eng.),
Secretaries.

Per A. F. LYALL.

CONSULTING ENGINEER'S REPORT.

Construction work in connection with the sinking plant at both shafts was proceeded with and good progress was made with the erection of the necessary buildings, quarters, and compounds. At the end of the year No. 1 Shaft was sunk to a depth of 74 ft., of which 60 ft. were timbered. At No. 2 Shaft the collar set was completed and preliminary sinking was about to be commenced. The west haulage from the South Shaft, Springs Mines, was extended into the company's area, and at the end of the year a distance of 149 ft. had been driven. A chamber for a haulage engine had also been cut, a distance of 29 ft. being accomplished. On February 23 of the current year a serious subsidence occurred at No. 1 Shaft, which at that time had reached a depth of approximately 90 ft. Fortunately, no lives were lost. The ground on the east side of the shaft gave way, resulting in the collapse of the shaft. The movement of ground probably originated in consequence of the heavy rains experienced previous to the accident. The subsidence has since been filled in, but taking into consideration the nature of the ground, the delay and expenditure involved, the re-opening of the shaft does not appear expedient. It has therefore been decided to move the site of the shaft a short distance and to make a fresh start.

C. E. KNECHT,
Consulting Engineer.

EXTRACT FROM MANAGER'S REPORT.

The west haulage, Springs Mines, entered West Springs area during October, 1918. Following are particulars of development in West Springs area to December 31, 1918:

Working Place	Total Footage	Footage on Reef	Footage Sampled	Reef Width Ins.	Assay Value Dwt.
East Haulage, West Face	149	149	130	17·42	3·08
East Haulage Engine Chamber	29	29	5	31·00	2·55
Totals and Averages ...	178	178	135	17·93	3·05

The total footage driven in Springs Mines area under clause 8 of the working agreement was 148 ft.

T. T. NICHOL,
Acting Manager.

DAGGAFONTEIN MINES, LIMITED.

(Incorporated in the Transvaal.)

Directors: F. R. Lynch (*Chairman*), H. C. Boyd, H. G. Latilla, E. Oppenheimer, W. Pott, Sir Evelyn Wallers. *Secretaries:* The Consolidated Mines Selection Company, Ltd. *London Secretaries:* Henderson's Transvaal Estates, Limited. *Head Office:* Johannesburg. *London Office:* Egypt House, 36-38, New Broad Street, E.C. *Formed* 1916. *Registered Capital:* £730,000.

Business: **Is developing a gold-mining property in the Far East Rand.**

EXTRACTS FROM THE REPORT OF THE DIRECTORS FOR THE YEAR ENDED DECEMBER 31, 1918.

To be submitted at the Fourth Ordinary General Meeting, to be held in Johannesburg, on May 23, 1919.

Under the flotation agreements, the Consolidated Mines Selection Company, Ltd., undertook when called upon, within a period of two years from March 28, 1916, to provide £200,000 further working capital against the issue at par of 200,000 shares. During the year the remaining 50,000 shares were called up, and a further 1,732 shares were allotted and issued to satisfy three-year options exercised in London.

The Capital of the Company at December 31, 1918, was therefore as follows:

Issued Capital, in shares of £1 each	699,775 shares
Held in reserve	50,[illegible] „
Registered Capital	730,000 shares

The flotation agreements covered the following options granted, calculated from March 28, 1916:

To the Daggafontein Gold Mining Co., Ltd.:

For three years at par on	134,126 shares.	
Less—Exercised during the year	1,732 „	
		132,394 shares

To the Consolidated Mines Selection Co., Ltd.:

For three years at par on	115,874 shares	
For four years at 22s. 6d. on	125,000 „	
For five years at 25s. on	125,000 „	
		365,874 „
Total number of shares under option		498,268 shares.

With reference to the option granted to Daggafontein Gold Mining Company, Ltd., to take up 134,126 shares in this company at par for three years from March 28, 1916, the Lords Commissioners of His Majesty's Treasury intimated that they would raise no objection to the allotment and issue to option holders of the shares for which they had the right to subscribe, provided that the money received in payment of such shares was invested in National War Bonds in the name of the National Bank of South Africa, Ltd., and that an undertaking was furnished by that bank that such bonds would not be disposed of during the continuance of the war and of one year thereafter without their Lordships' authority.

The cash receipts and expenditure from the inception of the company to December 31, 1918, were as follows:

	£	s.	d.
RECEIPTS.			
Working Capital—300,000 Shares at 20s. each	£300,000	0	0
Shares Issued against Options exercised at 20s.	1,732	0	0
Cash and Cash Assets taken over from Vendors	2,437	15	4
Interest Received and Sundry Revenue	4,527	15	6
Sales of Surplus Water	2,207	17	9
Owner's Share of Licences	36	10	11
Loan	68,960	9	[illegible]
	£379,902	8	6
EXPENDITURE.			
Transfer Duty, etc.	[illegible]	[illegible]	4
Shaft Sinking, Permanent Haulage Ways and Equipment	265,093	13	0
Estate Buildings and Improvements	138	15	0
Development	56,758	12	6
General Expenses	[illegible]	8	[illegible]
Guarantor's Commission—Loan	2,500	0	0
Interest on Loan	[illegible]	6	[illegible]
Balance, being Cash and Cash Assets after deducting Sundry Creditors and Credit Balances and accrued Interest to date	25,457	5	3
	£379,902	8	6

By taking up the above-mentioned 50,000 shares, the Consolidated Mines Selection Company, Ltd., liquidated its liability under the flotation agreement to provide £200,000 further working capital. As none of the options granted over further shares of the company expire until March 27, 1919, and as it was estimated that the funds accruing from the issue of the above shares would become exhausted early in July, it became necessary to arrange for the provision of further funds in order that the operations of the company might be carried on without interruption. With this end in view, an agreement was entered into with the Consolidated Mines Selection Company, Ltd., by which that company undertook to lend or procure loans under its guarantee of the funds required until March 27, 1919, up to a total of £100,000, on the following conditions:

(*a*) Interest to be charged at 1% above the Bank of England rate current from time to time, with a minimum of 6½%.

(*b*) The loan to be repaid by March 31, 1919.

(*c*) The consideration payable to the guarantors of the loan was a cash commission of 2½% (£2,500) and the right to call at par any shares not taken up by the holders of the options which mature on March 27, 1919, the decision of the guarantors to be given immediately after this company has notified them of the number of such options not exercised.

Further, this company agreed that if the loan is not repaid by March 31, 1919, a first mortgage bond would be passed over the property in favour of the lenders.

The loan of £69,798. 15s. 5d. shown in the balance sheet represents the amount called under the above arrangement, with accrued interest, to the end of the financial year.

CONSULTING ENGINEER'S REPORT.

Owing to the workings being inaccessible during the greater portion of the year on account of water, no development work was done. The water difficulties have now been overcome, and development work was resumed early in February. The pumping plant at the 2,000 ft. station at No. 1 Shaft was completed early in April. Work was then concentrated on unwatering the lower portion of the shaft and recovering the Main Station. At the end of the year the bottom pump station was completed, and pumping was started on January 2 of the current year. A dam is being built in the 2nd Level Drive South with a view to applying cementation to seal off the water encountered in this heading. At No. 2 Shaft the 500 ft. pump station was completed early in the year. The dolomite water below this level was successfully sealed off by cementation. As the application of the process involved a considerable time, the footage sunk for the year was only 509 feet. The total depth of the shaft at the end of the year was 1,028 feet, of which 1,012 feet were timbered.

C. E. KNECHT.

Johannesburg,
March 1, 1919.

ANGLO-FRENCH EXPLORATION COMPANY, LTD.

Directors. F. A. Robinson (*Chairman*), William Frecheville, Ernest G. Mocatta, Louis Ochs, Edward Wagg, Wm Henderson Clark, George R. Airth (*Managing Director in London*), W. Dalrymple (*Managing Director in South Africa*). *Manager in South Africa*: Edward H. Read. *Secretary*: S. D. Thomson. *Engineers*: John A. Dennison, J. A. P. Gibb. *Offices*: Salisbury House, London, E.C.2. *Formed* 1889. ***Capital*** : £500,000; debentures outstanding £255,000.

Business: The financing and promotion of mines and other businesses in South Africa, holds investments in many mines on the Rand.

ANNUAL REPORT TO DECEMBER 31, 1918

Your directors beg to submit their twenty-ninth annual report, being for the year ended December 31, 1918, together with the audited accounts for that period. The capital of the company remains as before, namely, 500,000 shares of £1 each, fully paid. The third drawing of debentures took place on November 29 last, when debentures to the amount of £15,000 were drawn in accordance with the trust deed, thereby reducing the amount of undrawn debentures to £255,000. The profit and loss account shows a net realized profit of £32,542. 3s. 6d., after payment of the interest on debentures. This amount, together with the balance of £41,705. 4s. 7d. brought forward from last year, has been placed to appropriation account, making a credit balance of £74,250. 8s. 1d. The usual valuation of the company's assets was made at the end of the year. This valuation, with the cash or equivalent of cash in hand, amounted to £817,917. 10s. 4d., which amount shows a surplus over the company's capital and liabilities of £62,917. 10s. 4d. Your directors recommend the payment of a dividend of 7½% for the year. After the distribution of this dividend and the payment of the commissions thereon, in accordance with various agreements and with the articles of association, there will remain a balance of £34,275. 8s. 1d. to be carried forward to next year's accounts.

The assets of the company as valued at December 31 last may be classified as follows:

British Treasury Bills	£39,650 16 8	
British War Loan 1929–1947	31,468 10 0	
British National War Bonds	49,317 5 11	
Union of South Africa Treasury Bills	59,500 0 0	
		£179,936 12 7
Cash and Loans, after providing for all liabilities		30,110 4 2
Other securities		23,004 9 9
Shares in Companies paying dividends		412,117 12 11
Shares in Companies at present non-dividend paying		172,748 10 11
		£817,917 10 4

The company's assets appear, as usual, in the balance sheet in the aggregate at or under cost, after making allowances for amounts written off.

The following are the companies in which your company has its principal holdings, namely: Brakpan Mines, Limited, Daggafontein Gold Mining Company, Limited, Kleinfontein Estates and Township, Limited, Modderfontein B. Gold Mines, Limited, Modderfontein East, Limited, Springs Mines, Limited, Sub-Nigel, Limited, and West Springs, Limited, on the Eastern Rand; City Deep, Limited, Crown Mines, Limited, Meyer and Charlton Gold Mining Company, Limited, and Village Deep, Limited, on the Central Rand; the Anglo-French (Transvaal) Navigation Colliery in the Middelburg District of the Transvaal; the Anglo-French Matabeleland Company, Limited, in Southern Rhodesia. Other important interests are in the Hollinger Consolidated Gold Mines, Limited, in Canada; Magadi Soda Company, Limited, in East Africa; and East Pool & Agar, Limited, in Cornwall.

During the year the mining industry of the Witwatersrand has been carried on under increased difficulties, partly due to the war, and partly to other abnormal conditions, namely, very heavy rains and floods in the early part of the year, and the serious influenza epidemic in the later months. These difficulties resulted in a reduced output, increase in working costs, and a reduction in dividends, in consequence of which the company's revenue has been adversely affected.

The board desires once again to express their thanks to the managing directors and the members of the staff in London and Johannesburg for the efficient manner in which the work has been carried out during a very trying period. Most of the members of the staff referred to in last year's report as on active service in His Majesty's Forces have now returned to their duties. The board records, with regret, the death of Lieut. Wm. Lambourne, who was killed in action on August 9 last. As will be seen by the accounts, the sum of £3,567. 7s. 7d. has been expended during the year in war grants, which brings up the total under this heading to £10,165. 0s. 1d.

In terms of the articles of association, Mr. F. A. Robinson and Mr. Wm. Frecheville retire from office, and being eligible offer themselves for re-election

For the Board of Directors,
F. A. ROBINSON, *Director*.
ERNEST G. MOCATTA, *Director*
S. D. THOMSON, *Secretary*.

PROFIT AND LOSS ACCOUNT FOR YEAR ENDED DECEMBER 31, 1918.

	£	s	d
To Directors' Fees	2,250	0	0
To Salaries (including Managing Directors' Salaries), Rent, Audit Fees, and Travelling, Office and General Expenses, Cost of Engineering Departments, London and South Africa including special fee paid to Mr. Wm. Frecheville for technical services, *less Transfer and other Fees and Amounts charged to other Companies*	15,277	10	2
To War Grants, including allowances to members of the Staff serving with the Army	3,567	7	7
To Cablegrams	233	16	9
To Donations	437	1	0
To Premiums on Insurance of Office Staff—London (balance)	192	0	2
To Realized Losses and Sundry Amounts written off	6,517	18	10
To Charges relating to business in Canada and elsewhere	2,827	7	1
To Debenture Trustees' Fees	210	0	0
To Debenture Interest	12,150	0	0
To Balance carried to Appropriation Account	32,545	3	6
	£76,208	5	1

	£	s	d
By Dividends, Commission, Interest and Sundry Credits	66,366	14	3
By Profits realized by Sales of Shares	9,841	10	10
	£76,208	5	1

The Mining Magazine

W. F. WHITE, *Managing Director.* EDWARD WALKER, M.SC., F.G.S., *Editor.*

PUBLISHED on the 15th of each month by THE MINING PUBLICATIONS, LTD., AT SALISBURY HOUSE, LONDON WALL, LONDON, E.C.2.

Telephone *London Wall 8938* Telegraphic Address: *Oligoclase* Codes: *McNeill*, both Editions

BRANCH OFFICES: 420, Market Street, San Francisco. 300 Fisher Bdg., Chicago

SUBSCRIPTION: U.K. and Canada 12s. per annum (Single Copy 1s. 3d.) Elsewhere, 16s. per annum (Single Copy 1s. 4d.)

Vol. XX. No. 6. LONDON, JUNE, 1919. PRICE ONE SHILLING

CONTENTS.

6—3

EDITORIAL

SIR Boverton Redwood, who died early this month, was the doyen of the world's oil technology, having grown up with the science and practice of petroleum mining and refining. His books are a permanent monument to his memory.

WE note the formation of the Chemical and Metallurgical Corporation, Limited, with a capital of £1,200,000, and having as directors Messrs. A. Stanley Elmore, Walter McDermott, Hugh F. Marriott, J. A. Agnew, and F. W. Baker. The primary object of the company is to work a new chemical process invented by Mr. F. E. Elmore for the treatment of complex ores. Interests in other new processes will be taken as opportunity offers.

ONE of the handsomest University endowments ever recorded in this country is being provided for Cambridge by a number of oil-men. The Burma Oil Company of Glasgow, the Anglo-Persian, the Anglo-Saxon (representing the Shell interests), and Lord Cowdray have between them subscribed 200,000 guineas to provide an adequate school of chemistry. Not only is the University to be congratulated, but the gift may also be regarded as a fitting reward to Professor W. Jackson Pope for his many services to the country during the war.

THE news that Mr. Theodore J. Hoover has been appointed head of the Mining Department of Stanford University, at San Francisco, is of unusual interest in this country. Judging by the extreme brevity of mention in the American papers, the appointment is apparently attracting more attention in this country than in the United States. Perhaps this is only to be expected, seeing that, as has been the case with his brother H. C., his professional work has been mainly connected with the Old World. When he announced his retirement to his native State and his abandonment of mining for farming, there were many who wondered how long his withdrawal from congenial activity would last. As a graduate of Stanford, as a man of wide experience, as a keen investigator, and as an expounder of mining and metallurgical practice, he has the qualifications desirable in a successful instructor in the science and business of mining, and it is well that he has come back once more to his proper sphere.

THE annual dinner of the Old Students of the Royal School of Mines was held on June 4, and proved a most successful gathering. Mr. E. T. McCarthy, who presided, announced that local branches of the Old Students' Association are to be formed in the chief mining centres abroad. Sir Alfred Keogh, in responding to the toast of the Royal School of Mines, said that 424 students and old students had joined up at the beginning of the war and of these no fewer than 174 had gained distinctions, a proportion of which the School might legitimately boast, for it proved the wonderful adaptability of the English mining man. Mr. E. B. Lighthill, the honorary secretary of the Association, informs us that the History of the Royal School of Mines and the Register of Old Students will be published within a short time.

THOUGH an internal combustion engine has a greater thermal efficiency than a steam engine, its use involves the wasteful dispersion of a large proportion of the heat generated, owing to the necessity of preventing overheating. This superfluous heat is extracted by circulating water and thrown into the atmosphere by radiators. Mr. W. J. Still has devised a method of utilizing this waste heat by passing the heated water to a steam generator heated by the exhaust, and employing the steam on the return stroke of the piston of the gas engine. This compound prime mover was described in a paper by Captain F. E. D. Acland, read before the Royal Society of Arts on May 26. A distinguished audience discussed the paper, and it was generally held that two separate engines should be used. We regret that, owing to exigencies of space, it is impossible to quote the paper at length in our columns.

AIRMEN are desirous of helping the mines in the matter of transport. Commander C. M. Dyott, in a lecture before the Royal Aeronautical Society, expressed regret that a certain company in Russia had not given him the opportunity of carrying 60 tons of machinery from the coast to the mine, 90 miles away. He said the conditions were such that three years were consumed in getting the plant across country, at a cost of £100 per ton, whereas he would have undertaken to carry it in as many months at a cost of about one pound per ton per mile. He also said he would like to help the mines in such countries as Peru by carrying plant across otherwise impassable rivers and mountains. Another proposal of similar character comes from the Central Aircraft Co., of London, which is desirous of establishing a commercial air service from Cape Town to Kimberley and Johannesburg, and a local service along the line of the Rand.

MANY miners who have served in the war have, on their return to their normal avocations, attempted to use gas masks for rescue purposes underground. The makers of certain instruments, also, have recommended their apparatus for use in mines. The Mines Rescue Apparatus Research Committee has therefore found it necessary to issue a word of warning to the effect that such apparatus as the army respirator and the Eeds helmet are not safe for use in mines. The main risk when attacking a mine fire, or in penetrating workings after an explosion, is attributable to carbon monoxide. A second risk, which is seldom of importance at the surface, but which cannot be disregarded in mines, is that an atmosphere may be entered which contains an insufficient amount of oxygen to support life. Neither the army respirator nor the Eeds appliance give the least security against either of these dangers, and this type of appliance cannot be looked upon as a substitute for self-contained breathing apparatus. This warning is all the more necessary as both the army respirator and the Eeds helmet will stop smoke, and for that reason they would give a person ignorant of the real danger a feeling of security when entering smoky air, and thus add to the probability of his being overcome.

Oil in Derbyshire.

The tapping of oil in Derbyshire by Lord Cowdray's drillers promises to be an event of prime importance. Our readers are aware that Lord Cowdray undertook the drilling campaign after having received encouragement from American oil-men, whose views he had reason to trust owing to his favourable experiences in Mexico. He has stood the expense of the drilling, and the Government has been in control, such control being advisable partly on account of the war and partly to avoid the many disadvantages following on unrestricted exploitation of oil areas. English oil-men and geologists have been frankly sceptical as to the results. Our American technical friends have just reason, therefore, to congratulate themselves on the success of their diagnosis. In our issue of February last we quoted Mr. T. Sington's paper on the subject read at Manchester, and we added a geological map giving the place-names associated with the drilling, so we need not refer to the matter at any great length now. The news came on May 26 that oil had been found in the Hardstoft boring at a depth of 3,077 ft. The oil gradually rose, and in the course of four days was 1,000 ft. up. The oil was then shut off, until storage facilities were provided. Probably news of a resumption of drilling will be published in the daily press before these lines appear in print. It is stated that the bore penetrated 6 in. only of the oil-bearing stratum. Little or no gas has come up the bore, and the oil is reported to be of light gravity and good quality. Hardstoft is about midway between Mansfield and Chesterfield. North-east of Chesterfield, at Brimington, another bore is down to a considerable depth, and results may be expected daily. Further north, nearer Sheffield, the Eckington bore has given off several blows of gas, and oil has been found here and there. The amount of information given by Government and S. Pearson & Son is meagre so far. It is too early yet to gauge the flow or the degree of importance of the discovery. It can, however, be said with truth that the flow is beyond the capacity of a celebrated mining geologist who undertook to drink all the petroleum found in Derbyshire.

Publicity in Technology.

Two years ago, in our issue of May, 1917, we printed an editorial discussing the advantages of publicity, from the points of view of the mining engineers, the metallurgists, and the financial controllers, of the various operations in which the services of our profession are employed. The new president of the Institution of Mining and Metallurgy, Mr. Hugh K. Picard, in his presidential address last month, took up the subject and pleaded for some relaxation of the throttling hand of secrecy for which English mining and metallurgical operations are noted. Coming from a metallurgist of his standing, personally and officially, his plea may have some effect. And surely no professional man, in his own experience, has suffered more from the exclusiveness dictated by the employer of technical skill than Mr. Picard himself. The fondness for secrecy on the part of Englishmen has often been discussed, and the explanations vary widely. One reason given is that England is not a producer of non-ferrous metals on any large scale, and that such business as it has is that of the custom smelter or of the confidential consulting chemist. Confirmation of this view is provided by the fact that in Cornwall, one of the few places where there is a non-ferrous metal output, every one is free to visit the mines and to exchange experience with the staffs. In the United States, where mines flourish exceedingly, the open door is the rule, though there are exceptions, such as at the nickel works, the copper refineries, and the electrolytic zinc plants. In America, as in England, the possessor of hard-earned knowledge is not out to help a rival in the production of special brands of metal. Another reason for British secrecy is the bashfulness or false pride which prevents a man from owning up to the fact that he does not know everything. An American, when conducting experiments or investigations, is always open to learn, and cheerfully writes an article lacking in precise information, with the express hope that some one will come to his rescue and give him useful points. Another alleged reason is that the Englishman is indolent and cannot be bothered to write articles or initiate private discussions after his routine duties are finished. Fourthly, there is the fear that in the interchange of experience the advantage may be all on the other side. Finally, the reason for secrecy does not usually lie with the professional man himself, but with his employer, who is keen to prevent any leakage of information and thus to protect his capital outlay against depreciation through any act of a rival.

Whether or not any or all of these reasons hold water, the fact remains that the transactions of the representative English non-ferrous society are not so rich in original contributions to the technology of metallurgy as the council would like them to be. The same has to be said of the English press covering the same subjects, for it is obvious that it cannot compare with the excellent technical journals published on the other side of the Atlantic. Here we may say that the press of this country suffers under more disabilities than the professional society in the obtaining of papers and other contributions. For instance, many mining engineers and metallurgists object to giving their countenance to what they regard as trade organs; while directors of mining companies suspect editors of attempting to obtain private information that will help them in Stock Exchange speculations. We have discussed at some length the various reasons for the comparative poverty of technical writings on non-ferrous mining and metallurgy in this country; but, briefly, our view is that the best and most extensive writings are to be found in countries where there is the greatest amount and the greatest variety of successful mining.

The foregoing considerations relating to secrecy are concerned only with the internal affairs of the profession. Yet another reason for sealing the lips of the engineer is to be found at Somerset House, the home of the tax-assessor. This factor was well exemplified by Mr. F. Douglas Osborne in his speeches at the meetings of the Gopeng and Tekka-Taiping held at Redruth last month. No mining engineer can be more deservedly proud of his work than Mr. Osborne, whose firm is thoroughly conversant with every condition in the Malay Peninsula, and is noted for marvels of economical operations. Both Mr. Osborne and Mr. James Wickett, the chairman of the companies, would be delighted to respond to the plea for publicity. But every time Mr. Osborne has made a speech detailing the excellent prospects at these mines, his words have found their way back to Somerset House, to be used as levers for further exactions. Thus at the meeting last month he announced his intention of keeping his mouth shut. The same attitude has for many years been deemed advisable by companies operating in Spain, for the tax-assessor there looks for plunder at every stage of the operations. This accounts for the brevity of the yearly report and the chairman's speech of the Rio Tinto Company. It is not possible for either us or Mr. Picard to fight the factor of secrecy arising from the desire to protect the industry from unjust taxation. Our function is confined to exhortation relating to causes within the profession, and in this connection it is to be hoped that Mr. Picard's plea will have some influence.

The Price of Gold.

Though the Inchcape Committee and the committee appointed by the United States Government reported adversely in connection with the subsidizing of gold mines, a general impression appears to prevail that something is to be done. The authorities on economics are, apparently, not sure what will happen if any change is made in the present method of paying for gold, or in the present control of the destination of the gold output. As an experiment in this direction, the Australian Government decided to permit the free export of gold for three months. The results have been kept quiet and no information is available as to the amount sent out of the country. The only definite statement is one made by Mr. F. A. Govett at the meeting of shareholders in the Ivanhoe company held in London last month.

He said that the company had been allowed to export some of its output and that the financial advantage was considerable; but he could not say how much was exported or what the price was. It is not clear that Australia would care to export gold to any extent, seeing that the metal will be required in helping the foundation of many new manufacturing industries according to the policy referred to by us in a recent issue. If export were free, much gold would find its way to India, as it did before the war. On the other hand the Indian mines have been suffering severely from the restrictions of sale, but after the grievance had been aired publicly for two months the Government has afforded relief. After the stoppage of shipments to England, the Indian mines were allowed to deposit their output in the Bombay mint to the credit of the Bank of England, and the Bank gave them credit for the amount in sterling in London. The companies had to remit back from London to India through the usual banking channels in order to pay the wages and other local costs. With the price of silver advancing, the Indian exchange gradually increased, until two months ago, at the time of the public protest, the rupee stood at 1s. 6d. instead of the par 1s. 4d. Since then the exchange has gone still further against the mines, and now stands at 1s. 8d. The companies therefore were suffering to the extent of 25% in their remittances to India. It seemed hardly credible that the Government could continue an arrangement which, though grateful enough in war time, began to work to the detriment of the producer. It was obvious that the gold, being in India, should be given the Indian value. The Governments have now recognized this anomaly and have agreed that the Indian mines shall be allowed to deposit a sufficient proportion of their output with the Indian Mint to meet their local requirements.

The controllers of the Transvaal mines have been hoping that the Union or the Empire would come to their assistance, and Sir Evelyn Wallers, in his capacity as president of the Transvaal Chamber of Mines, has continued to draw the attention of the Governments to the precarious position of many of the producers. The Union Government is, however, obdurate with regard to a bonus on gold production, and the only comfort it can proffer to the mines is a promise to consider the case of each mine separately when a time arrives that closure, owing to extinction of the margin of profit, is contemplated.

Another event connected with this subject is the resumption of shipments of gold from Canada to the United States. This appears, however, to be a Government measure undertaken in connection with American exchange, and does not concern the mines.

Until the time we went to press, the sole statement on which hopes of the gold producers generally, other than those in India, are based is the utterance of the Chancellor of the Exchequer, who said: "There is nothing in the report of Lord Inchcape's Committee to suggest that producers of gold are not entitled to obtain for their produce the best price available in the most favourable market, and I am now considering in what manner this can be secured." This freeing cannot be effected without removing restrictions on the moving of gold from one country to another, so perhaps the Chancellor has in the back of his head the compensation of necessitous mines for the disadvantages arising from the restrictions. But the Chancellor is adamant on the price of gold and would not dream of interfering with the standard of value between nations.

Rand Mining Conditions.

In an earlier issue this year we gave particulars of the dividends paid by gold mines on the Rand for the year 1918, showing that the total distribution exhibited a considerable decrease as compared with preceding years. This condition is brought about by several factors. In the first place several mines are exhausted or rapidly approaching their end. Secondly, the average grade of many of the old mines is diminishing with depth. Thirdly, the cost of operation has substantially increased owing to the rise in prices and the inability to keep going at full capacity owing to scarcity of labour. During 1918 two other factors, of a temporary nature, had considerable influence in the diminution of output and profits, namely, the serious floods during the earlier part of the year, and the influenza epidemic toward the latter end of the year. The batches of yearly reports now arriving clearly demonstrate the position at the mines and give some indication of present and future conditions on the Rand. We had intended to use the statistics contained in them for the purpose of giving a general review of the position, but on further consideration we came to the conclusion that the figures would present the case in too gloomy a setting. The factors of the floods and influenza should not be included, as their effect has passed away. A more satisfactory presentation of the position can be given by the monthly figures since the turn of the year. The latest complete figures received in this country are those for February, and these we reprint in the accompanying table. From these figures, and from the general information given in the yearly reports, a fairly clear idea can be gained of present conditions and prospects.

[illegible]

[illegible]	Total Yield	Working Cost	Yield per ton s. d.		Cost per ton s. d.	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Brakpan Mines	81,850	51.749	39	7	25	1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Cons Langlaagte	49,414	40.544	23	11	19	9
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Crown Mines	183,948	169.873	29	6	27	5
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ferreira Deep	49.690	42,116	30	8	26	7
Geduld	60.046	39,217	30	5	19	10
Geldenhuis Deep	50 514	55.393	23	9	26	1
[illegible]	[illegible]	[illegible]	[illegible]	11	[illegible]	[illegible]
Govt G.M. Areas	179.658	110,064	35	7	21	9
[illegible]	[illegible]	[illegible]	22	[illegible]	[illegible]	[illegible]
Knight Central	28.557	27.702	26	8	27	8
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Langlaagte Estate	48.917	38,412	25	8	20	1
Luipaard's Vlei	20,950	20,902	22	3	22	2
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Modderfontein B.	115,691	55.137	48	2	22	11
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	11	[illegible]	[illegible]
New Heriot	14,153	14.487	28	0	28	8
New Kleinfontein	64,120	62.446	24	0	23	4
New Modderfontein	168,843	74,573	43	3	19	1
New Primrose	15,317	14,104	19	0	18	1
New Unified	11.040	9.289	17	11	15	1
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Princess Estate	24,913	27,534	23	10	27	6
Randfontein Central	153,190	145,588	22	5	21	7
Robinson	41.857	37.425	23	5	20	11
Robinson Deep	49.834	50.491	27	8	28	1
Roodepoort United	22.797	23,956	19	1	20	7
Rose Deep	55.751	46.548	23	6	19	7
Simmer and Jack	42,643	41,800	23	0	22	6
Simmer Deep	42.622	45.167	22	6	23	10
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	6	[illegible]	[illegible]
Van Ryn	31,599	27,251	20	4	17	6
Van Ryn Deep	94,992	47,454	41	5	21	11
Village Deep	59,629	56.316	26	0	24	7
Village Main Reef	21.795	20.334	25	8	23	11
West Rand Cons.	33,362	33,030	23	2	23	1
Witwatersrand	34,942	32,447	22	9	21	1
Witwatersrand Deep	32,928	35.608	24	1	26	1
[illegible]	[illegible]	[illegible]	[illegible]	11	[illegible]	[illegible]

It will be seen that there are forty-seven names in the list of mines. Bantjes has been omitted, for the yield reported for February was derived from a clean-up only. In estimating the position at the various mines, it is convenient to divide them into four classes: (1) Prosperous mines; (2) mines that may last for many years, though mostly containing low-grade ore; (3) mines in a precarious position owing to low grade and difficulties connected with mining operations; and (4) mines approaching exhaustion. In the first class we may include most of those in the Far East Rand: New Modderfontein, Modderfontein B, Modderfontein Deep, Government Areas, Van Ryn Deep, Geduld, Brakpan, Springs, and Sub-Nigel. The only mine in the older part of the Rand belonging to this class is Meyer & Charlton. In class (2) come City Deep, Crown Mines, Consolidated Langlaagte, Langlaagte Estate, Rose Deep, Consolidated Main Reef, Nourse Mines, Witwatersrand Gold, Durban Roodepoort Deep, Robinson Deep, Village Deep, Kleinfontein. In class (3) are Randfontein Central, East Rand Proprietary, Knight Central, Knights Deep, Luipaard's Vlei, Jupiter, Simmer Deep, West Rand Consolidated, Geldenhuis Deep, Aurora West, Roodepoort United, Witwatersrand Deep, Princess Estate. In section (4) are to be placed: City and Suburban, New Heriot, Ferreira Deep, Village Main Reef, Ginsberg, New Goch, New Primrose, Robinson, Simmer & Jack, Van Ryn, Wolhuter, and New Unified

It is no doubt an invidious task to make these classifications, and probably many readers on the controlling boards and among shareholders will disagree in detail. For instance, it may be urged that Sub-Nigel cannot be classed with the Modders and Government Areas, that City Deep should be in class (1), that Van Ryn and Ferreira Deep should be in class (2), and that East Rand Proprietary should be in class (4). It is likely also that Randfontein Central will eventually win its way into class (2).

The critical question during the past year or two has been the ability or otherwise of a third of the mines on the Rand to make ends meet. Under the circumstances the results have been such as to warrant congratulations to the men in charge. No mine has actually gone under owing to costs exceeding the income, though a large number are perilously near the boundary line. The increase in available labour, the possibility of getting mining supplies locally, and the resumption of shipments from England and America, together with improvements in underground practice, will combine to ease the position, and it is probable that many of the companies at present on the edge of disaster will recover, though they will not all resume the distribution of dividends.

As the old mines disappear, new properties in the Far East Rand are taking their place. Daggafontein, New State Areas, West Springs, and Modder East are on the road toward production. Plans are being laid for the development of Spaarwater, Vlakfontein, and Cassel-Clydesdale, and opportunities are awaited in connection with East Geduld, Grootvlei, and other properties. Finally, exploration in the Heidelberg district affords in many quarters the hope for an extension of mining activities farther to the south. The Heidelberg campaigns form the most interesting feature of speculative mining in South Africa at present, and for this reason we devote considerable space to the subject in the Mining Digest this month.

REVIEW OF MINING

Introduction.—The Allies' peace terms have not yet been accepted by Germany and Austria, and attempts are still being made by the defeated nations to obtain more favourable conditions. In this country the coal-mining unrest continues to exercise an evil influence on the resumption of trade. Though the number of miners now at work has been restored to the 1913 level, the output is much less, and the estimated production for the year beginning July 1 is about 25% less than normal. The gold question has again been discussed, and concessions have been made to Indian mines in the matter of exchange. The Australian copper mines are mostly closed owing to lack of market for their output, and the Broken Hill companies have suspended the payment of dividends owing to the difficulty of finding an outlet for their lead now that the Imperial Government is not buying it. Labour conditions in the Lena district are unsatisfactory, and it is stated that the men have taken control of the mines in Bolshevik fashion.

Transvaal.—The gold producers have again placed their case before the Union Government, and have foreshadowed the closing of a number of low-grade mines. The Government declares its willingness to appoint composite committees to consider the case of each individual mine whenever the directors decide that the time has arrived for closing. We refer to the general position of the mines on the Rand and to the gold question in our editorial pages.

The event of the South African share market this month has been the scare in connection with Springs Mines. The event has caused more stir locally than here, and the fall in the quotation of the shares was much greater in Johannesburg than in London. The results for February and March were comparatively disappointing and naturally gave rise to disquietude. Mr. Carl R. Davis was then appointed consulting engineer to the Consolidated Mines Selection group, in succession to Mr. C. E. Knecht, and he made a thorough examination. His opinion is that development has not proceeded far enough to indicate correctly the value of some of the ore reserves or to make the mining routine ideal. The controllers have given shareholders access to the assay plans, so that nothing is being hidden. It does not appear that the set-back is more than temporary.

A month or two ago a serious accident at Modderfontein B was recorded, due to the explosion of the main air-compressor pipe. The official inquiry has traced the cause to one of the compressors, inside which was found a deposit of carbonized oil mixed with copper oxide. The view is that this copper oxide acted as a catalyser, first igniting the carbon and afterwards the oil.

The Daggafontein company announces that the Union Government has approved its application with regard to the area to constitute the mine. The mynpacht area will approximately be 1,257 claims, the discoverers claims 179, and leased from the Government 450, while 173 claims will be given in exchange for the New Geduld Deep mynpacht, which is situated in the middle of the southern end of Geduld farm. The total claims will be approximately 2,059, but this is subject to survey. The Daggafontein company's property will consist of the part of Daggafontein farm adjoining the eastern boundary of Springs Mines.

The Union Corporation has broken new ground by reducing the denomination of the shares of one of its mining companies, the Modder Deep, from £1 to 5s., by splitting each share into four. It is true that Rand Mines, Ltd., shares were split in a similar way in 1901, but this is a holding, not a mining, company. Consolidated Mines Selection shares are 10s., the reduction from £1 having been effected during the gloomy days before the development of the Far East Rand. The only mining company on the Rand with a share less than £1 is Crown Mines with 10s. At one time it was occasionally considered advantageous to have shares of £4 denomination in order to secure Paris quotations. New Modderfontein has shares of this denomination, and with the market price at £25 discovered the existence of drawbacks as well as of advantages, but on seeking to split the shares found that the Treasury had objections. Now that Modder Deep has taken a similar step, possibly New Modder will revive the scheme.

The Consolidated Gold Fields of South Africa has relinquished technical and financial control of the Southern Van Ryn Reef Gold Mining Co. in the Nigel district of the Far East Rand. It is only a few months since the Gold Fields acquired 35,000 shares and assumed technical control, and as late as April announced that a vertical shaft was to be commenced. The original promoter of the company, Mr. W. E. Bleloch, was in favour of working from the outcrop. Presumably the withdrawal of the

Gold Fields was caused by this conflict of opinion.

The position at Crown Mines indicates a further decline in the average content of the ore, owing to the approaching exhaustion of the richer section that used to be Robinson Central Deep. Mr. Stuart Martin is in favour of a policy of closer selective mining in order to maintain the average assay-value of the ore sent to the mill. Large sums are still required for development and for the sinking of new shafts, so that the costs will necessarily be high. Particulars of recent results of mining are given elsewhere in this issue.

The Vereeniging Estates is about to become a supplier of timber. Twenty-four years ago, 4½ million trees were planted, and some of these are ready for felling. A railway has been built to the forest and a saw-mill has been erected. As each block of trees is cut down, young trees will be planted, according to the best practice in forestry.

The treatment plant at the Rooiberg tin mine is to be closed for a few months, during which time further exploration and development will be vigorously conducted. During April, 1,300 tons of ore and 675 tons of accumulated slime were treated, for a yield of 34·3 tons of concentrate. This sold for £3,698, against which there was an expenditure of £5,539. The tin ore is distributed very erratically in this district, and of late years there has been considerable difficulty in keeping the mill employed to capacity.

Cape Province.—The Cape Copper Co. was obliged, a year ago, to stop the shipment of matte and high-grade ore owing to absence of shipping facilities. The mine and smelter were kept going and the output was stored. It is now announced that, owing to the fall in the price of copper and the high working costs, it is impossible to continue operations. During the period of waiting for more favourable conditions, some exploration and development will be done. The company announces that the new property in India, the Rakha Hills, is now regularly producing, and that the output has been about 100 tons of blister copper per month during the last four months.

Diamonds.—Diamond-mining is receiving widespread attention in various centres in South Africa. Last month we referred to the formation of the South-Western Diamonds, Ltd., the object of which is to dredge for diamonds off the shore at Pomona, "German" South-West Africa, and of the Makganyene Diamond Syndicate, Ltd., which is to operate at a place 140 miles west of Kimberley. Several other companies are showing considerable activity. The Crown Diamonds, a company formed ten years ago by the Lewis & Marks group, is issuing additional capital in order to resume operations at Driekop and Ruby, in the Kroonstadt district. The Roberts-Victor, owning property twenty miles north-east of Boshof, Orange Free State, another of the Lewis & Marks group, ceased mining before the war owing to impoverishment, but continued exploration on adjoining properties. Resumption is now being considered, and it is also intended to re-treat the old tailings. The Koodoo Diamond Mining Syndicate is commencing washing at Uitkyk, Cape Province. The New Eland Co., Ltd., of which Sir Thomas Cullinan is chairman, is working a property in the Boshof district, Orange Free State. The Monteleo company is working a property of that name at Winburg, Orange Free State. With all this activity in diamond-mining, the Government sees an opportunity of imposing an export tax on stones, partly for revenue purposes and partly to encourage the foundation of a diamond-cutting business in South Africa. Apparently the action of the South African Diamond Corporation in establishing cutting factories in Great Britain, where legless ex-soldiers are employed, is not altogether pleasing to the Union Government.

Rhodesia.—The doings of the Cam & Motor have been wrapped in mystery lately. The last yearly report was circulated privately, and the meeting of shareholders was not advertised. Moreover, the company failed to issue the usual monthly returns of output. It now appears that the mill was closed at the end of last year pending further development. This policy became necessary, not so much because there is any serious shortness in ore supply, but because the grade and nature of the ore varies widely. Some of the ore is graphitic and some carries very coarse gold, while native copper interferes with cyaniding. It is held that, if a greater number of working faces are provided, the ore as delivered to the mill can be made to average more regularly in content and character, so that the full capacity may be continuously maintained, the recovery increased, and the costs decreased. The company is being reconstructed, the new £1 shares to be issued with a liability of 7s. 6d. This is a heavy assessment, and will provide £220,000. By its means, the debentures, £50,000, will be redeemed, various liabilities will be met, and £65,000 will be provided for additional working capital. We understand that Sir Abe Bailey has recently secured some measure of control and that one of his engineers, Mr. S. R. Jameson, has been appointed resident director.

The Lonely gold mine continues to be a most satisfactory producer and to develop well in depth. During the year 1918, 54,320 tons of ore gave 49,560 oz., worth £209,712, and £48,273 was distributed as dividend, being at the rate of 25%. The reserve is estimated at 176,097 tons averaging 24·1 dwt., as compared with 145,616 tons averaging 18·69 dwt. the year before. The consulting engineer, Mr. C. B. Kingston, has altered the method of mining so as to avoid so large a proportion of friable foot-wall rock being mixed with the ore as stoped. The foot-wall is now removed before the lode is stoped, and it is used as filling, the stopes being packed close up to the working faces.

The option on the Huntsman group of claims has been exercised by the Rhodesia Gold Mining & Investment Co., Messrs. Lewis & Marks' Rhodesian finance company. Developments have exposed 8,672 tons averaging 13·77 dwt., and the prospects in depth are good. This ore will yield sufficient gold to pay for the option and for the cost of the development and equipment.

The report for 1918 of the Rezende Mines, which is now in the control of Sir Abe Bailey, contains two statements with regard to the ore reserves. The directors give the figure at 447,690 tons, and the consulting engineer, Mr. S. R. Jameson, vouches for 175,374 tons averaging 12·66 dwt. A verse in the Bab Ballads says:

To say that Bailey oped his eyes
Would feebly paint his great surprise.

In this case it is the shareholders that get the disconcerting shock.

Mr. Edmund Davis, in his address to shareholders in the Wankie Colliery Co., said that further expansion was impossible owing to the restricted space available for surface plant. The directors had therefore decided to commence workings at another point on the company's concession, where borings had shown a thickness of from 28 to 30 ft., divided by a parting.

Nigeria.—The Jantar company has increased its capital to £90,000, by the creation of 30,000 new shares of £1 each, in order to purchase Blocks 3 and 4 at Kuru from the Niger Company. The purchase price of the property is £10,000 cash and 10,000 shares, and the other 10,000 shares will provide the necessary working capital. These blocks adjoin the property of the Kuru Syndicate, which was formed as a subsidiary of the Jantar company a year ago. The syndicate's mine is developing well, as may be seen by the monthly tonnage of output from October to April: 9, 7, 12, 16, 20, 23, 30.

The Ropp company reports a steady increase in the output of the dredges, the figure for 1918 being 839 tons, as compared with 670 tons in 1917. For the first four months of 1919, the output has been 339 tons. The company is now among the first ten tin producers of the world. The reserve of dredging ground is estimated to contain over 9,000 tons of black tin, and the other areas 2,000 tons. Leases of additional ground have recently been obtained. The profit for 1918 was £52,150, of which £41,250, less tax, has been distributed as dividend, being at the rate of 3s. per 5s. share. Additional capital is being raised by the issue of 55,000 new 5s. shares at 18s. 6d. each.

Australia.—The Golden Horse-Shoe at Kalgoorlie has met the labour scarcity by working two shifts instead of three, both above and below ground. By arranging a few extra working faces, all the available underground men were kept fully employed. It has been possible, by dispensing with the night shift, to reduce the number of surface employees. During 1918, the ore raised amounted to 146,664 tons, as compared with 176,028 tons the year before; the yield was £332,620, as compared with £411,546, and the dividend £37,500, as compared with £82,500. This mine was at its best from 1899 to 1909, and since then, though the output has still been large, the profits have been small. With the increase in cost and shortage of efficient labour, the conditions still cause anxiety, though the general outlook is better. In spite of little labour being available for development, the reserves have been fairly well maintained, standing at 733,102 long tons averaging $9\frac{1}{4}$ dwt. per ton.

Increased costs have wiped out the distributable balance of profit at the Sons of Gwalia gold mine at Mount Leonora, West Australia. This mine, under Messrs. Bewick, Moreing, & Co.'s management, has been a steady producer for twenty years, and, without having given any spectacular performance, has provided regular dividends. During the last few years the average content has decreased, but a more adverse circumstance has been the growing cost of labour and supplies and the shortage of reliable and first-class labour. During 1918, gold worth £190,091 was extracted from 148,394 tons, and the profit was £12,720. Practically the whole of this was paid as income tax in England and Australia.

Last month we announced that Broken Hill is again the victim of a strike. At the time of writing work has not been resumed. The contract for the supply of lead by the Associated Smelters to the Imperial Government expired on March 31, and prompt part payment for concentrates cannot now be made by the smelting company. The mines have, in consequence, found it advisable to suspend the payment of dividends, until alternative outlets for the lead are settled.

The Waihi company is preparing to resume exploration at depth, which was suspended owing partly to the difficulty of obtaining the necessary pumps and partly to the expressed desire of the Government that all available labour should be devoted to gold-production. The new pumping plant has been ordered, at a price just double that quoted before the war. The company found a great advantage from the Hora-Hora hydro-electric plant owing to the scarcity and high price of coal. It is probable that operations could not have otherwise been continued. The demand for electric current at Auckland and other centres of population within a commercial distance from Hora-Hora is considerable, and is increasing rapidly. In all probability the Government will exercise its option and purchase these works for public use, but continuing to supply the requirements of the Waihi mine.

The Irvinebank tin-smelter in Queensland was closed recently, greatly to the misfortune of many small mines and alluvial workings. The Government has come to their rescue by advancing £100 per ton on the concentrate.

In the March issue, our Melbourne correspondent dealt at some length with the campaign of oil-drilling in Papua undertaken by the Commonwealth Government. The results so far obtained have been disappointing, and the expenditure of £100,000 has given little tangible return. The consensus of geological opinion is, however, favourable to ultimate success, and an extension of the profitable oil region of Burma and the East Indies is confidently predicted. It is now announced that the British Government has agreed to spend £50,000 in further testing, the Commonwealth Government contributing an equal sum.

India.—The Balaghat, in Mysore, is to have another chance. From 1900 to 1907 dividends were paid, but before and since the results have been disappointing, and the mine never approached in importance its big neighbours of the Kolar group. During the last few years, developments have been restricted, owing to shortness of funds, which have been provided solely from the balance of current profit. The directors now announce that they are preparing a scheme for raising additional capital in order to inaugurate a new campaign of exploration and development.

Developments at depth at the Hutti (Nizam's) gold mine, in Hyderabad, have given poor results lately. No payable ore has been found in the deepest level, at 3,450 ft., and in the meantime the reserve is rapidly running out. The directors are considering ways and means, and are debating whether it is advisable to raise further capital or to discontinue operations.

Malaya.—The policy of the Tronoh company in adopting dredges has been amply justified, as will be seen by reference to the report for 1918. The two dredges extracted 613 tons of concentrate, as against 114 tons obtained by sluicing in No. 3 mine, and 557 tons recovered by tributers. The total yield was 1,367 tons, as compared with 1,044 tons the year before. The dredges accounted for 288 tons of the increase. The cost per yard is 50% higher than in 1917, owing to increases in wages and the price of materials. The profits for the year were £124,095, and £80,000 was distributed as dividend, being at the rate of 50%. A third dredge has been ordered and should be ready to start in a year.

Canada. — Our Toronto correspondent sends information relating to oil-boring activities in Northern Alberta. News also comes to hand that the Anglo-Persian Oil Company, through the D'Arcy Exploration Company, is seeking concessions in the Peace River district in north-east British Columbia. The territory desired is a continuation of the district that is attracting attention in Alberta.

Two of the big companies at Cobalt, the Nipissing and the Mining Corporation of Canada, have been spending much time and money examining new properties. The former examined over a hundred properties, chiefly in Ontario, but also in Arizona, California, Idaho, Missouri, Montana, and Nevada. Only two properties were acquired, and both proved dis appointing. One was a gold property at Fort Matachewan, Ontario, and the other was the Butte Copper Czar mine, in Montana. The Mining Corporation investigated 160 proposals coming from Canada and the United States.

In spite of difficulties, the Corporation's interests in Siberia have been carefully nursed. These include a gold mine in Yenesei province, a coal deposit in Primorsk, and a lead-zinc-silver mine, formerly controlled by Germans, near the coal deposit.

MINING IN SPAIN.

By E. MACKAY HERIOT, M.Inst.M.M., F.G.S.

The author discusses present conditions in Spain and gives some information as to the engineering and mining outlook.

IN the September number of the Magazine I gave an outline of some of Spain's industries and of present conditions as affected by the war. I referred principally to coal, potash, platinum, and social questions. In the present article I propose to continue the discussion of the more interesting facts regarding Spain's industrial life.

PRICES AND TAXES.—For the moment no one here seems to know what awaits us in the near future. Will the Bolshevik wave be blown this way and paralyse all work, or will a period of prosperity set in? There is to-day more unrest than has ever been known before. There are general strikes at Barcelona, Sevilla, Cordoba, Huelva, Coruña, and there may be others. The papers are strictly censored, and one does not know what is happening. The cost of living has risen so high that it is very difficult for the people to keep hunger from their doors, let alone clothe themselves. Even those products that are national, such as wheat, olive oil, meat, and rice, have gone up very much in price. Meat in 1914 was sold at 1·2 pesetas a kilo; now it is about 3 pt. Olive oil has risen from 10 to 20 pt. an aroba. Wheat costs 12 pt. the fanega (43 kilos); now it is 20 pt. Rice has risen from 0·44 pt. per kilo to 0·85. These are main food stuffs, and it gives an idea. There has been a lot of cornering and secret exportation, and this must be given as the reason for the rise in prices. The Government has taken energetic steps to stop these abuses, but for those who know the country, one need not say that the task is one of great difficulty. In Spain no individual is highly taxed; the rich and poor are taxed very much alike. The taxes are for the most part indirect, the foodstuffs being taxed. This, of course, is very unfair to the working classes, as the tax hits them far harder than it does their wealthy neighbours.

Strikes to-day are very different from what they used to be. Formerly the men presented you with a paper pointing out the cause of the strike and stating their terms. This morning I received a telephone call from Huelva to say that the general strike broke out yesterday in the town, but no one knows why or what the men ask for; not even the Governor knows. The idea of so many general strikes at the same

VIEW IN THE LEAD-MINING DISTRICT BETWEEN LA CAROLINA AND PUERTOLLANO time can only be to make it difficult for the Government to suppress the movement, for the army is not large enough to be in all parts of Spain simultaneously. The result is they drain the province of civil guards to safeguard the capital, leaving the rural parts exposed.

Speaking of taxes, the two chief taxes on the mining industry are the 3% shaft mouth and the 2 per mil on capital for foreign companies. The former is levied on all saleable ore at shaft mouth. The 2 per mil tax was, until a few months ago, 1 per mil. In some cases companies are formed locally to avoid this. There is a trend to raise taxation. I read to-day that the Government proposes new export duties, among which is galena 32 pt. per ton. It was 15 pt. before. The new duty on iron pyrites is 1·75 pt., copper matte 115 pt., copper precipitate 90 pt., tin 3,000 pt., and many more. What influence a passing of this law will have I cannot say with any certainty, but I do not think it can possibly benefit Spain. The mere fact of placing an export tax of 10 pt. per ton of galena some years back assisted the smelter trust, but it has had a negative effect on lead mining. A tax of 11½ pt. on manganese ore should be sufficient to shut down the few mines working. The production of copper precipitate on some of the Huelva mines hardly pays. The 90 pt. tax should stop any new ores being put to heaps for leaching purposes. These taxes have not come into force, and are only proposed.

AMERICAN INTERESTS.—There are many rumours current regarding an American invasion. I do not know what truth there is in it. I was told in Sevilla that the American Embassy has taken over 600 flats in Madrid. Some days later on the way to Huelva, I was informed it was 500. It may be a case of exaggeration. Anyway, one must not lose sight of the fact that a considerable amount of American advertising is going on in Spain, a thing which was little known before the war. I read this morning an advertisement: "A responsible company in the United States wishes to lease with option to buy a metalliferous mine with a future." Exactly what they mean I do not know, but they, no doubt, want something good in Spain in the mining line. There is always an attraction in mining far away from home. Perhaps this is the reason that Americans and not British are taking up Spain. I note that most wares that were British before the war are now American. [We have already recorded in our pages the visit of an American Commission to Spain.—EDITOR.]

NEW RAILWAYS.—Spain considers herself the connecting link between Europe and Africa for the future traffic of the latter continent. They are here discussing the necessity of a line joined up with the southern line of France at Dax, traversing the whole of Spain, via Pamplona, Soria, Madrid, Toledo, Ciudad-Real, Cordoba, to Algeciras; from Algeciras to Tangier by boat, and thence by rail into the heart of Africa. The project presented by the State engineer, Gonzalez Echarte, to the Government covers the ground between France and Madrid, a distance of 400 kilometres. No gradient will be more than 2%. He urges two sets of rails, and the service to be worked electrically. The present journey takes twelve hours in the fastest train. Echarte's scheme will make it possible to cover the distance in about half the time. The American International Corporation, hearing about this, sent to Spain one of its experts, Dr. J. T. Case, to report on the scheme. Dr. Case took four months to collect data, and his report was evidently favourable, for Mr. Fred Lavis, the American railway engineer, was sent out, and assisted by Spanish engineers made a six months' study of the line and found Dr. Case's report justified. Lavis wished to add two branch lines, one from near Logrono to Calatayud, joining up the Madrid-Barcelona line, the second branch from Pamplona to Pasajes. The first thus finds an outlet in the Mediterranean, and the second in the Atlantic. Mr. Lavis' project is for a single line with steam driven traffic.

Only a short time ago the Public Works Minister brought up this railway project in Congress. It is of more importance than is apparent at first sight. It will not only make Spain the traffic agent between Europe and Africa, but will open markets for her own wares. It will also be the means of deviating a part of the world's shipping. The African line will be connected up with Dakar on the Atlantic coast near Cape Verde, thus shortening the distance by sea between Europe and South America. The *Gaceta* has just published a Royal Decree in which the Public Works Minister refers to the series of studies and conferences which have taken place on the initiative of the engineer, Don Carlos Mendoza, concerning the new idea of a floating tunnel through the Straits of Gibraltar, which could have an exceptional importance for Spain if it was realizable. The Royal Decree continues to state that a commission has been appointed to study the matter. It is proposed to float the tunnel under water. The depths are too great for an underground tunnel.

ELECTRIC POWER.—One reads between the lines that Spain has great ideas for her future prosperity, and, at the rate of her advancing, one can be optimistic in this. The Government is thinking seriously of installing all over the peninsula a general transmission line for electric energy. Spain is rich hydro-electrically, and only a small proportion of this is exploited. The permanent commission which has studied the matter has come to the conclusion that there is a total of 2 million kilowatts, of which 300,000 are actually harnessed. Electric energy needs industries, and the country is poor in these. As a rule the industrial centres are distant from possible power stations, and thus expensive transmission lines are necessary. An electric line or system of lines run by the Government would permit of the establishment of generating plants far away from the industrial centres. There are also coalfields where the coal is of poor quality, little suited for transport but convenient for the generating of energy at pit mouth. The Royal Commission calculates the cost at 130 million pesetas for a double line of 4,800 kilometres, three-phase, 50 cycle, 120,000 volts; using copper wires 50·75 and 100 square millimetres. With 120,000 volts tension, a maximum of 25,000 kilowatts can be transmitted a distance of 300 kilometres with a loss of 12% energy.

MINING.—I come now to the minerals of the peninsula, continuing my article in the Magazine for September, 1918.

Gold, the great lurer, has been a disappointment. Several attempts have been made to win the gold in the alluvials and lodes, but I do not know of a single success. I have seen the Roman alluvial workings, which could only have been for gold, but they would never pay to work to-day. According to data I have, all the Tagus valley is auriferous in the Province of Caceres. The most interesting deposits are in the Alagon valley, where I believe little or nothing has been done.

Tin mining has not also been very successful in Spain. Alluvial tin is found in the Valdeflores district of Caceres Province. Tin is mined in Corùna Province. Orense Province has one working tin mine, which also produces wolfram. Salamanca Province has a small output of tin. Caceres and Badajoz Provinces should be prospected for tin and wolfram.

Most of the phosphate rock required for Spanish industry comes from the north coast of Africa, but the lack of boats during the war has given local mines a better chance. At Aldea-Moret and Logrosan (Caceres) phosphate rock is mined. The 60 to 70% quality is transported from Logrosan over a road 100 kilometres in length to Caceres town, and from there by rail to Salamanca. The phosphate occurs in narrow veins.

The only place I know of bismuth being mined in Spain is at San Sixto, near Conquista (Cordoba). At present no work is done there.

The so-called topaz mines in Salamanca do not produce real topaz, but quartz of a beautiful topaz colour.

Only a few hundred tons of antimony concentrate are produced annually in Spain. The mines are in Ciudad-Real and Lugo. The first I have visited and found the occurrence of ore in the veins very irregular, but they have never been properly investigated.

Wolfram is found chiefly where tin is mined. In Badajoz one mine is working at La Oliva de Merida. Salamanca produces some wolfram, and Zamora adds a little.

Molybdenum is only produced in one mine, in the Province of Granada at Queretar. The mineral is wulfenite, the molybdate of lead.

Asphalt is worked in the Maester district, Province of Alava. The yearly output is 4,500 tons. In Navarra there are two working mines, each producing a little over 100 tons.

Sulphur is mined from two concessions in Almeria.

Cinnabar is worked chiefly at Almaden, Ciudad-Real, where 600 tons of quicksilver is produced per year. In Granada small quantities are mined. In Oviedo there are some small concessions working, but the total yearly output is valued at only 130,000 pt.

Silver is produced at Hiendaencina in Guadalajara. The mines are now very deep.

Fluor-spar is mined at Irun (Guipuzcoa). The yearly output is 300 tons.

Pitchblende occurs at Monasterio in the Province of Badajoz. It is found as small black grains in a felspathic gangue. These grains are 0·5 to 3 millimetres in size. When concentrated they have proved to be as pure a pitchblende as that of Joachimsthal. Autunite and carnotite are also present. The pitchblende is not at present found at a greater depth than 10 metres, but it seems to be well worth further investigation.

At Santa Ana (Badajoz) vanadium minerals have been worked. They are, however, replaced by lead and zinc after 30 metres depth. The deposits are very irregular.

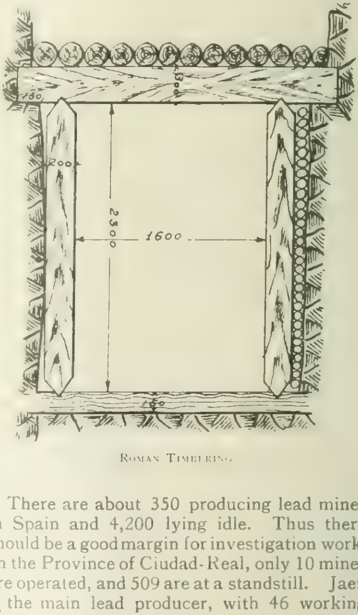
The lead situation in Spain I described in an article in the Magazine of May, 1914, and there is very little new to add. Of the total world's output of about 1,200,000 tons, the Penarroya smelters produce 152,000 tons, over one-tenth. Thus one can truly say that Spain's lead industry is of great importance. The principal lead fields lie right across the southern part of the peninsula, from near Portugal to the Mediterranean sea at Cartagena. In this old country, the mother of all the Americas, where the Romans and Phœnecians worked, and where the Moors held sway, one would expect that nothing new could exist, and yet this is not the case, as many of us are aware. There are still virgin deposits only awaiting better transport facilities. I refer more especially to such localities as north of Andujar and between La Carolina and Puertollano. Andujar and La Carolina are in the Province of Jaen, and Puertollano in Ciudad-Real.

Lead mining in Spain has lacked sufficient investigation. Of the many mines I have seen only a very few have been investigated on a large scale. I remember the Guindo mine at La Carolina, a large concern to-day, but some years back with only a few months' ore in sight. Since then investigation and development have been pushed on hand in hand, with the result that the mine has proved itself a rich one and has paid many millions of pesetas in dividends. It was solely a matter of investigation on a large scale. For the most part these mines are worked with very little capital, and operations are only carried out on known ore-shoots.

As the price of lead has now fallen, many mines have had to close down, but the main difficulty is that the smelters have little sale at present.

I notice that the Penarroya company has come to an arrangment with the Minerals Separation company to use their patents in Spain. This country knows little concerning flotation, we having got along up to the presnet with the ordinary wet methods. I know of ores on at least one new field that will baffle the ordinary concentrators. The lead and zinc sulphides are so finely divided and mixed up that they appear to be a double sulphide. There is also chalcopyrite and pyrite present.

By the time these mines are opened up, no doubt flotation will have been introduced into Spain, but with what success in such cases it is doubtful to say at present. In parts of this country we find men very expert at concentration. I have had men concentrating by hand silver-lead-zinc ore, containing also chalcopyrite, iron pyrite, barite, carbonate of iron, calcite, quartz, and slate. We were washing old dumps. The barite was eliminated from the blende by burning the concentrate. The former fell to powder and could be screened off. The carbonate of iron gave most trouble, but it was found that by brushing over the surface of the ore, under water, with a hand jig, a good amount of these carbonates could be separated from the blende. The semi-fine concentrates were crushed in a hand jig, using a bed. This needed the finest workmanship. I give the above explanation in order to show what the Spanish mines can do. Personally I have done a lot of hand and mechanical dressing in Spain, and have always found the men equal to any emergency and very willing.



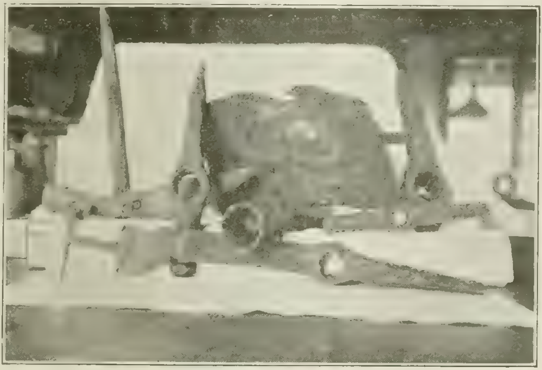
ROMAN TIMBERING.

There are about 350 producing lead mines in Spain and 4,200 lying idle. Thus there should be a good margin for investigation work. In the Province of Ciudad-Real, only 10 mines are operated, and 509 are at a standstill. Jaen is the main lead producer, with 46 working mines and 1,046 not working. Murcia has 186 active and 511 inactive, but it produces less than Jaen.

What astonishes one is the small amount of scientific prospecting. I say scientific to differentiate from the ordinary methods of the so-called practical man. The Romans, when they worked in Spain 2,000 years ago, seemed to possess a kind of certainty for locating mines. They do not appear to have spent much time on doubtful properties. They had, of course, more to pick from. The Phœnicians used scientific methods for prospecting for silver.

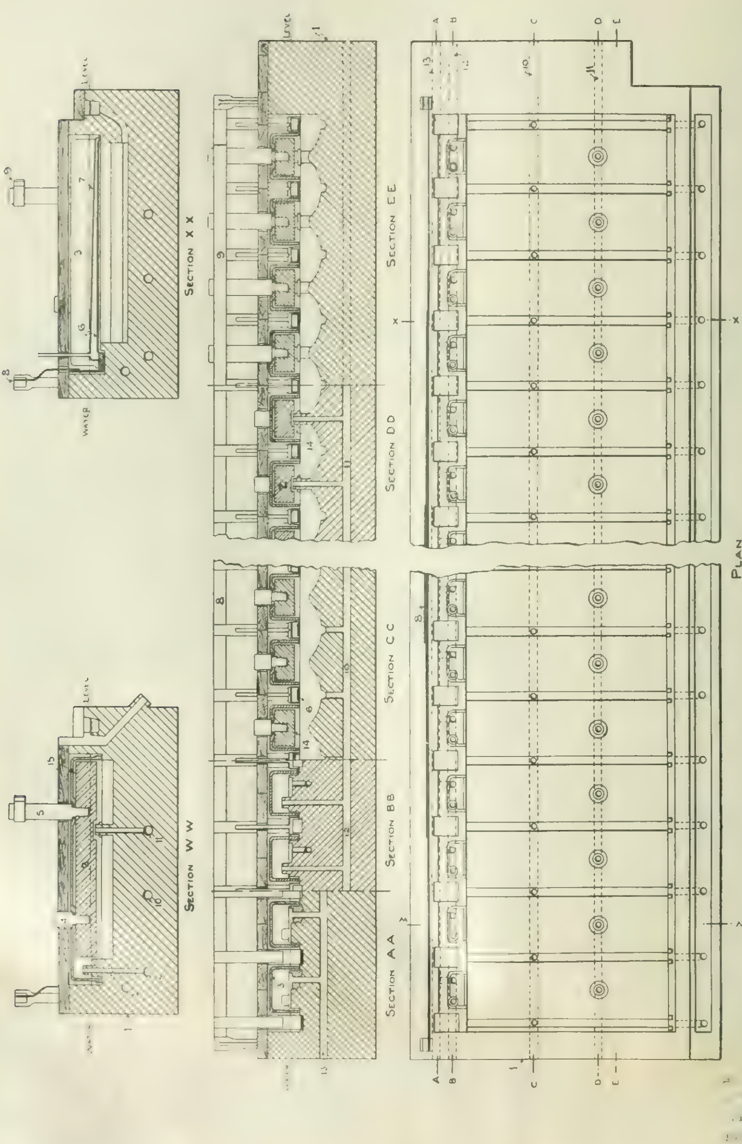
Silver is not an element that is found like gold, but has to be extracted as a rule from the lode from sulphides. The Phœnicians had large silver-mining camps, and won practically all their silver from galena. They are said to have employed the "wunschelrute" for prospecting. Cicero calls it "virgula divina" or "virgula mercurialis." Lynceus, one of the Greeks who went to Russia for gold, was said to have a sharp eye and could see the minerals under the earth through a branch. What these men knew about prospecting is a closed book to us, yet from what I have seen in Spain I think the Romans used much scientific knowledge in their prospecting. On the other hand, we do know a lot of the way the Romans worked their silver-lead mines in Spain, though some things are hard to believe. At El Centenillo and Cerro Muriano, the Romans went to 200 metres depth. At the latter they lifted 4 tons of water per minute. The easy explanation is given that they put in an adit from some great distance, but it has never been found. Four tons of water per minute is a great amount of water, even with present-day pumps. Their system of timbering levels is very interesting and much better than we do to-day. I give a drawing of Roman timbering. The implements they used were much the same as ours; there was, of course, no blasting, the faces being cracked by burning and then wedged open. They used the Archimedean screw, lead-piping, and copper buckets for unwatering. When one finds a chain with anklets for some poor slave, one's thoughts are apt to run back to those heathen times when many of the slaves lived underground. The Roman chiefs in Spain did not forget the value of education for their communities. I saw an old marble table at Rio Tinto with the inscription: "I would wish well to the School of the high and mighty Jupiter." And the brass sheet found at Santo Domingo with the laws as to how the slaves should be treated shows that some sort of humanity played a part. I give herewith a photograph of Roman implements.

In ordinary times, Huelva has an output of 60 million pesetas worth of iron pyrites, copper ores, and copper, or over 90% of Spain's total of these. The ore deposits are found in a zone 240 kilometres in length by 25 kilometres broad, running east and west, beginning in the west of the Sevilla Province and ending in Portugal. The most important mines are situated near the contact of the culm slates with porphyry. The occurrences of pyritic ore in Huelva have been described many times, and there is no call to do it again just now, but to one mine I will make a reference, because it is something new. The Torerera mine is situated on the Zafra-Huelva line, a few miles from the township of Calanas. This is the only mine as yet opened up which has no iron outcrop. Up to the present only such mines have



ROMAN MINING TOOLS FOUND IN SPANISH COPPER MINES

been worked as have well defined gossans. The only mineral signs at surface of the Torerera mine are small manganese outcrops. These, although of a poor quality, were responsible for taking up the concession. Later on, the Explosives Company took over the property and put down three shafts. One shaft cut an iron pyrites body at 15 metres depth. The shafts proved the dip to be 45°. The second shaft cut the pyrites at 85 metres depth. Since then the width has been ascertained and the ore-body has been proved to be important. One would expect that a find of this kind would give initiative to much speculation and investigation, but this has not been the case. There are innumerable manganiferous outcrops untried in depth.



THE JENKINS CELL, FOR PRODUCING CAUSTIC SODA, CHLORINE, AND HYDROGEN BY THE ELECTROLYSIS OF BRINE.

THE JENKINS ELECTROLYTIC CELL.

By HENRY C. JENKINS, A.R.S.M.

This cell is employed for the production of caustic soda, chlorine, and hydrogen by the electrolytic decomposition of brine.

THE Jenkins cell is the result of a serious attempt to enable the many advantages of gravity cells to be more fully utilized in industrial apparatus for the production of soda and chlorine. Gravity cells offer many advantages, among them being that they do not require the use of mercury and can have very large passages through all their parts, and do not depend for their action upon any diaphragms, and particularly diaphragms that need an adjusted degree of porosity. Some attempts, as is well known, have been made at different times to use this type of cell, such for instance as at Aussig, but several of the special problems of the type were not met by the designs adopted there, nor indeed were they until the present cells now to be described were designed. There are several important features connected with the electrolysis of brine that can be utilized to great advantage in this type of cell, such for instance as the increase in density in the catholyte and the decrease in density in the anolyte as the operation proceeds; but unless steps are taken to avoid it, there is associated with this latter advantage a reduction in strength owing to migration of ions and loss of chlorine from the anolyte, followed by a formation of hypochlorite. This occurs in all cells of whatever type, but takes place at first to so small an extent as to be absolutely negligible; then, as the anolyte further weakens, it grows in importance and ultimately becomes serious. The cell to be now described contains means by which these unfavourable actions are entirely avoided, and a gravity cell giving the highly satisfactory current efficiency of from 85% to 95% is obtained without mercury, or diaphragms, or needing any special attention after its initial adjustment.

The cell consists of a comparatively shallow tank (1) with a bottom which is corrugated and also provided with four longitudinal pipes (10), (11), (12), (13), each of which deals with a separate function of the cell. The shallow tank or tray is made in concrete, this material having been found over lengthened practical trials to be highly satisfactory. The parts liable to wear, such as edges and pipe openings, are arranged in earthenware, and the whole presents an object of great durability. Gravity cells have hitherto been made with comparatively small anodes and cathodes, but in the present cell each anode will deal with 60 to 70 amperes without any forcing of the cell. The anodes (2) are rectangular blocks of graphite arranged transversely across the cell, and are each enclosed within a single earthenware bell (3), to which they are attached by two graphite rods (4) and (5) of differing lengths, screwed in through openings in the tops of the bells, with the joints made good with pitch. It will be noticed from the section herewith, that the anodes themselves almost fill the bells, and that the space for anolyte is made very small indeed. The possibility to do this is one of the special features of the cell.

Between each pair of bells a cathode (6) of flat iron is arranged; this is fitted with a collector (7) for the hydrogen. The cathodes are arranged one above each of the valleys in the floor of the cell, while the anodes are arranged above the corresponding ridges.

The iron cathodes (6) are all connected up to the common bus-bar (8) of the cell, and the longer of the two carbon rods (5) on each anode is connected to another bus-bar (9), these bars being formed in the usual way of copper strip and "tapered" as regards the number of strips from the point where each is attached to the leads. The cells follow the usual practice of being arranged in series of 50 or more, according to the voltage of the generator.

Reference has already been made to four longitudinal pipes (10), (11), (12), (13), formed in the concrete body of the cell. From each of these pipes there is an opening to a particular part of each anode or cathode space. One of these pipes (10) is for the simple purpose of emptying the entire cell when it is desired to clean or shut down, and this connects with all the valleys in the floor of the cell. The second of the pipes (11) supplies the fresh electrolyte fed from time to time into the anode spaces immediately beneath the lower and active surfaces (14) of the carbon anodes. The third pipe (12) opens into the gas space (15) above the anolyte underneath each bell, and this serves for the discharge of the chlorine produced. The fourth pipe (13) also opens into the anolyte space immediately adjacent to the preceding, but at a point just below the surface of the liquid; this opening serves for drawing off the slightly weakened electrolyte at the same moment that fresh electrolyte is being fed to the cell, synchronization being effected by an automatic arrangement of great simplicity and efficiency that it is not yet possible to publish owing to consideration of foreign patents. This arrangement when once adjusted also controls the strength of the lye produced from the cells, the strength usually fixed being that of 10% in sodium hydrate as being a convenient basis, although much higher concentration can be arranged for special conditions. The supply of electrolyte to a whole roomful of cells is controlled from one master valve, and the labour of supervision is thus reduced to a minimum.

The cells are provided with wooden covers so as to retain their own heat as much as possible. They yield a supply of chlorine, soda, and hydrogen, each of very high degree of purity. Beyond occasional periodic cleaning and the regular supply of electrolyte to the cells, which supply also can be made automatic when desired, the cells call for little attention. It will be noticed that no gas is subjected to any contamination by another, or from oxides of chlorine, but all are liberated under ideal conditions.

The rejected anolyte has usually a very slightly acid reaction, and in all but very special cases merely requires to be heated before it can be mixed with fresh strong brine and used again to supply the feed tanks.

Some facts about the voltage of all electrolytic cells will not be out of place here. The voltage that should be adopted in any given installation is entirely dependent upon the other factors of the installation, such as those of the cost of power, and the cost of construction of the cell units. Actually anything above about 3¼ volts could be adopted when electrolysing brine; indeed the operation takes place at as low as 2·8 volts, but the lower the voltage chosen the smaller will be the output from any given apparatus, and in general it is economical to work at from 4 to 4¼ volts per cell. Cases such as those of very high power costs occur where the use of a lower current density is indicated, and here the cells can be operated at the lower voltages with economy. It is claimed that the Jenkins cell by reason of the cheapness of its construction has a considerable advantage where such a course is economically justified.

The Jenkins cell has been subjected to a progressive and exhaustive series of tests, and has come through them satisfactorily. The C.I. (1914) Syndicate, Ltd., undertook the proving of the efficiency of the design by erecting two cells at Stratford, London, E. These were built with steel frames lined with cement, and each cell contained nine bells. Encouraging results were obtained at once. Tests were made, with continuous runs, by Dr. F. Mollwo Perkin, and also by Dr. W. R. Ormandy and Mr. J. S. Highfield, who prepared a joint report. Both of these reports were made on the cell before the automatic control valve had been devised. Mr. Bertram Blount reported on the purity of the hydrogen produced by the cell. His sample showed 98·3%, the balance consisting of air due to leakage during sampling.

Mr. H. N. Morris, chairman of H. N. Morris & Co., Ltd., chemical and colour manufacturers, of Manchester, who is also a director of the C.I. (1914) Syndicate, Ltd., was encouraged by the results to take a licence to erect four cells in his firm's works at Denton; the results obtained from these were so good that subsequently his firm obtained a licence to erect 100 cells in new works at Middlewich, Cheshire, where a constant supply of the finest brine is available. It was found that the body of the cell can quite conveniently and cheaply be made of cement reinforced with expanded iron, thus dispensing with the steel jacket employed in the original design. Fifty cells were built there, together with power plant, compressing machinery, and accessories. Though, through difficulty in securing sufficient Acheson graphite anodes from Niagara, only 28 cells have so far been completed, yet regular deliveries of liquid chlorine were made to the Ministry of Munitions, and a contract for a supply up to 80 tons per week to the Chemical Warfare Department was arranged, after inspection of the works by Lord Moulton and Mr. Stanley Smith, director of the department concerned. The signing of the armistice put an end to the contract. The British Alkali and Chemical Company, Ltd., is being registered with a capital of £400,000 in 300,000 7½% cumulative participating preference shares and 100,000 ordinary shares, with the object of taking over the Middlewich works and increasing their annual output to 1,800 tons of caustic soda and 1,500 tons of chlorine (equivalent to 4,500 tons of bleaching powder). There will be produced in addition large quantities of vacuum salt, and 16,000,000 cubic feet of hydrogen. It is intended to utilize this gas in the production of synthetic ammonia by means of a process, similar to that successfully employed in Germany during the war, which is the joint invention of the Hon. R. C. Parsons and Mr. H. C. Jenkins. It is worthy of note that Mr. Stanley Smith is joining the board of the new company.

THE COPPER INDUSTRY OF THE SOUTHWEST:

ARIZONA, NEW MEXICO, AND SONORA.

By W. TOVOTE, E.M.

The "Southwest" is the biggest copper-producing region in the world, and contains many famous mines such as the Copper Queen, United Verde, the U.V.X. Miami, Inspiration, Ray, and Chino.

(Continued from May issue, page 277)

GEOLOGICAL SECTIONS.—Before proceeding to describe the Mountain Region, I will give tables indicating representative geological sections, and diagrammatic sections of the rocks at Bisbee, Globe, and Ray. For the tabular matter I am indebted to Mr. F. L. Ransome. The diagrams are given on the next two pages.

REPRESENTATIVE GEOLOGICAL SECTIONS'

ACCORDING TO F. L. RANSOME.

1. GRAND CANYON SECTION.

Governing Northern Arizona.

Erosion-surface.
CARBONIFEROUS:
Kai bab limestone, 400 ft. to 600 ft.
Coconino sandstone, 250 ft. to 350 ft.
Supai formation, 1,250 ft. to 1,400 ft.
Sandstone, shaly sandstone, and shale.
Redwall limestone, 600 ft. to 700 ft.
Unconformity
DEVONIAN: Temple Butte limestone, 0 ft. to 100 ft.
Unconformity.
CAMBRIAN:
Muav limestone, 450 ft. to 475 ft.
Bright Angel shale, 25 ft. to 375 ft.
Tapeats sandstone, 0 to 285 ft.
Great Unconformity.
PRE-CAMBRIAN:
Younger Pre-Cambrian "Grand Canyon Series." Nearly 5,000 ft. of conglomerate limestone, shale, sandstone, and quartzite.
Unconformity.
Older Pre-Cambrian, granite and schist.

2. BISBEE SECTION.

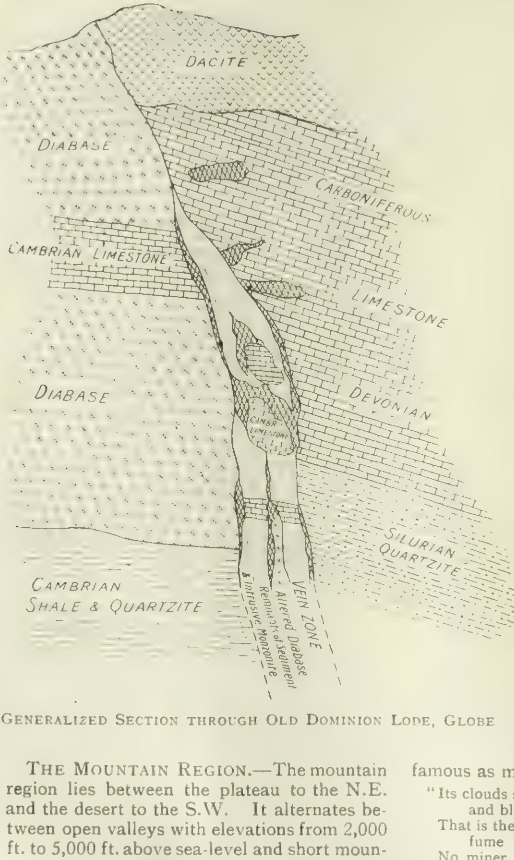
Erosion surface.
CRETACEOUS:
2,000 ft. of shale, quartzite, limestone, and conglomerate.
Unconformity.
PORPHYRY INTRUSION.
(Cretaceous ?)
CARBONIFEROUS:
Naco limestone, 3,000 ft. +
Escabrosa limestone, 700 ft.
DEVONIAN:
Martin limestone, 340 ft.
SILURIAN:
Possibly represented in a persistent layer of white quartzite, 6 ft.
CAMBRIAN:
Abrigo limestone, 770 ft.
Bolsa quartzite, 430 ft.
Great Unconformity.
PRE CAMBRIAN:
Pinal schist and granite rock.
Note: Mineralization attributed to intrusion of quartz-porphyry, whose principal exponent is the porphyry-plug of Sacramento Hill, antidates Cretaceous era

3. CLIFTON-MORENCI SECTION.

QUATERNARY:
Gila conglomerate.
Unconformity.
Basalt, Rhyolite, Andesite } Flows, Late Tertiary ?
Quartz-porphyry, Diorite-porphyry, Diabase } Intrusions. Late Cretaceous ?
CRETACEOUS:
Shale and quartzite, 600 ft.
Unconformity.
CARBONIFEROUS:
Tule Spring limestone, 500 ft.
Modoc limestone, 180 ft.
DEVONIAN:
Morenci shale, 150 ft.
ORDOVICIAN:
Longfellow limestone, 200 ft. to 400 ft.
CAMBRIAN:
Coronado quartzite, 200 ft.
Basal conglomerate, 30 ft.
Great Unconformity.
PRE-CAMBRIAN:
Pinal schist and granite.
Note: Mesozoic porphyries, to which mineralization is ascribed, have profoundly affected Cretaceous strata in contact metamorphism, but no ore deposits have yet been found in these Cretaceous sediments.

4. GLOBE, MIAMI, RAY SECTION.

QUATERNARY:
Gila Conglomerate.
Basalt flow.
TERTIARY:
Andesite-Tuff.
Unconformity.
Dacite flow.
Diorite-porphyry, Quartz-porphyry, Diabase } Intrusions.
CARBONIFEROUS:
Tornado limestone, 1,000 ft. +
DEVONIAN:
Martin limestone, 325 ft.
SILURIAN: ?
Troy quartzite, 400 ft.
Basalt flow, 25 ft. to 75 ft.
CAMBRIAN:
Mescal limestone, 225 ft.
Dripping Spring quartzite, 450 ft.
Barnes conglomerate, 10 ft. to 55 ft.
Pioneer shale, 150 ft.
Scanlan conglomerate, 0 to 15 ft.
Great Unconformity.
PRE-CAMBRIAN:
Pinal schist and granite.
Note: The porphyries, to which mineralization is attributed, are later than the Carboniferous, probably of late Cretaceous or early Tertiary age.



GENERALIZED SECTION THROUGH OLD DOMINION LODE, GLOBE

THE MOUNTAIN REGION.—The mountain region lies between the plateau to the N.E. and the desert to the S.W. It alternates between open valleys with elevations from 2,000 ft. to 5,000 ft. above sea-level and short mountain ranges of a general north-westerly trend and elevations from 5,000 ft. to nearly 10,000 ft.

The boundary with the plateau country is well marked in Arizona, but disappears in New Mexico. The line between mountain region and desert is more difficult to draw, and depends more upon the individual susceptibility to heat, alkali-dust, thirst, and the optimism of not calling all mesa and valley lands in the Southwest desert, that is, as far as irrigation has not transmuted them into wonders of fertility. I shall subdivide the mountain region into Northern, Central, Eastern, and Southern areas.

THE NORTHERN AREA comprises the Jerome, Mayer, and Prescott districts, all in Yavapai county.

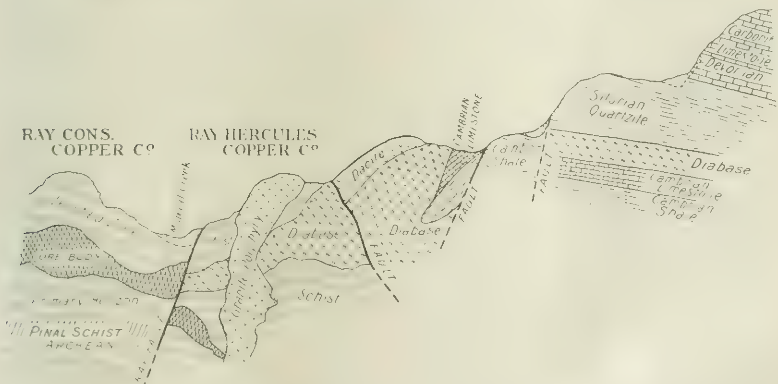
Jerome, on the north slope of the Black Hills, was for years the ugliest mining camp in Arizona, and that is saying something, with the most magnificent view, also a deserved superlative. Below the town, which clusters on the bleak, barren slopes around the mine, stretches the fertile Verde valley with its silver-ribbon of river. Beyond rise in mighty sweeps the precipitous walls of the plateau country, crowned farther out by the sharp peaks of the St. Francisco mountains, the highest elevation in Arizona.

The plateau rim, with its tints in red, yellow, and buff, the chocolate colour of lava masses here and there, the velvet lining of great pine forests, and far out the blue peaks, bearing their gleaming snow cap the greater part of the year, this panorama steeped in the glory of an Arizona sunset is one of the sights, so overwhelming and unearthly in beauty, that words cannot express it. But for years it was seen from Jerome only through clouds of sulphur fumes, so thick that they blurred the landscape, and so strong that they suffocated any æsthetic thought. Paraphrasing Carl Schnabel, more famous as metallurgist than as poet:

> "Its clouds so sulph'rous and acid kill tree, shrub, and bloom;
> That is the herald of mining, the dear old smelter fume
> No miner can evade it. No, all must smell and hate it,
> Must breath it, spit and cough, and never curse enough."

Now the old smelter on the hill is dismantled and a new plant, of from 3,000 to 4,000 tons daily capacity, has been erected at the foot of the mountain at Clarkdale. The United Verde Copper Co. has built here a little model city of friendly brick and concrete houses, and gardens are springing up, and even a few trees brave the dangerous neighbourhood. A few miles east a second smelter has been blown in recently, that of the United Verde Extension Copper Co. It is of about 1,000 tons daily capacity, and is said to be the last word in

GENERALIZED SECTION THROUGH BISBEE.
The ore-bodies in Sacramento Hill are "porphyritic" and of low grade. Those in the Limestone are of comparatively high grade, and are the origin of Bisbee's greatness.



APPROXIMATE GEOLOGICAL SECTION AT RAY.
The ore bodies are disseminated low-grade deposits in Pre-Cambrian schists. The payable parts consist of the zone of secondary enrichment. Workable primary ore is found in diabase intrusions.

smelter construction with mechanical labour-saving appliances in every possible direction. Now the miner on the hill has the consolation that other people get the first chance at the sulphur fumes, when the wind is right.

Unless the demand for sulphuric acid overtakes its manufacture, the United Verde smelter will probably continue to be an unenjoyable landmark. They have quite a problem in smelting that ore. It is mostly solid pyrite with chalcopyrite. The copper content used to be around 6·5%, but ore of considerably lower grade is now smelted. Some gold and silver goes with it, I believe about 60c. per ton. For flux oxidized cap-rock is mined which contains very little copper but about $6·00 in gold. The sulphur content varies from 15% to 32% and a good deal of it has to be roasted off. Recent practice has evolved a matte of only 18% copper. One great disadvantage of the Jerome smelters is their relatively great distance from other mining districts, which could furnish fluxing ore. As it is calcareous and silicious ores have to be brought in from quite distant places.

Jerome had for years only one single mine, the United Verde, controlled by Senator W. A. Clark, of Butte. It is probably the most valuable individual mine in the Southwest. The ore is found in great lenticular pyritic masses in Pre-Cambrian schist. Ore-bodies several hundred feet in all dimensions are the rule. Ore is also found in veins with quartz gangue. This ore is higher in grade but less in quantity. The only surface indications were rusty quartz reefs and the low-grade oxidized gold ore. Expert after expert came and went with the usual non-committal or unfavourable report to his respective employers, but Senator Clark was impressed with the showing and found among his entourage in Butte, where one of the greatest copper districts of all times had been opened by sheer pluck and against scientific advice, men who were imbued with the Butte spirit and shared his views. The mine was tested and proved a winner. While the ore was never startlingly high in grade, it occurred in immense quantities. But the mining engineer had lost standing with the Senator, who has ever since relied upon the hard-headed hard-rock miner rather than upon his brother with a string of letters behind his name, until the present manager of the U.V., Robert E. Tally, proved to his satisfaction that even after a college course a man might become a real miner.

Senator Clark's success started a great prospecting campaign, which other than a half-hearted success in the Copper Chief mine, six miles S.E., did not produce anything but a number of expensive failures, some with tunnels and shafts 1,000 ft. deep. During the last few years James S. Douglas and associates (George E. Tener of Pittsburg, Major A. J. Pickrell of Prescott, and others) optioned what is now the United Verde Extension property, and continued exploration at a point where a former company had left off.

The property adjoins the U.V. at the north, but a fault of perhaps 2,000 ft. throw separates it geologically. Paleozoic strata and recent conglomerates and lava-flows obscure the surface. Schist was found only at the 600 ft. level, while this rock appears on the surface many hundred feet above the shaft collar on U.V. ground. After extensive search an ore-body was found on the 1,200 ft. level. The maximum dimensions of this were perhaps 200 ft. length and height by 15 ft. thickness, but most of it was chalcocite. The vein was very steep, dipping east above the 12th level, but reversing unexpectedly below. The search for it on a lower level was discouraging for a while, due to this dip-reversal, but led to the discovery of the big ore-shoot which made the mine famous. This new ore-body is approximately 300 ft. by 250 ft. by 200 ft., and contains nearly 2,000,000 tons of ore averaging 17% copper.

This discovery started a veritable orgy of mine-promotion. From a hundred to two hundred new companies sprang up, mostly around Jerome, but also hundreds of miles away, most of them with "Jerome" or "Verde" in their names. The capitalization ranged anywhere from $5,000,000 on paper to $500,000 in cash. While many were legitimate development companies, others mined only from the pockets of a gullible public. Of the new ventures the Jerome-Verde and the Shea Copper Co. seem to be assured of success, while several more have a good chance. The output from Jerome for the month of August, 1918, was 12,000,000 lb.; 7,500,000 lb. coming from the U.V., and 4,500,000 lb. from U.V.X.

A well-mineralized belt extends from Jerome to the south with an area of Pre-Cambrian schist equivalent to the Jerome schist. The formation here is known as "Yavapai Schist." It consists of metamorphosed intrusive and sedimentary rocks, including remnants of limestone.

On the south slope of the Black Hills the Shannon Copper Co. is successfully reopening the Yager Canyon mine, which had been idle for years after producing for a long time and attaining a depth of 800 ft. Farther south a number of properties are producing steadily in the vicinity of the small town of Mayer. One is the Arizona Binghampton, formerly known as the Stoddard mine, about six miles north of Mayer. A flotation plant of 175 tons daily capacity is at work on ore averaging 3% copper. Part of the mill-feed used to come from the adjoining Copper Queen Gold Mining Co. The production is given as close to 500,000 lb. copper per month.

South of Mayer are the Blue Bell and De Soto mines of the Consolidated Arizona Smelting Co., of Humboldt. These mines together produce about 10,000 tons of ore per month. The grade is about 3·3% copper with $1·70 in gold and silver. The ore is concentrated and smelted at the smelter town of Humboldt, eight miles N.W. from Mayer. The Humboldt smelter treats annually over 100,000 tons of ore and concentrate, a large part of which is custom ore.

In Mayer itself is a smelter owned by the Big Ledge company, which also owns the Henrietta and Butternut mines. The company has attracted much unfavourable attention. Both mines and smelter are idle in spite of considerable reported ore reserves.

Recently a good deal of prospecting has gone on in this vicinity and several companies have opened very encouraging showings. If it was not for the war there would be a good deal more activity here.

About twenty miles south of Mayer, George M. Long, one of the discoverers of the United Eastern gold mine at Oatman, has taken over the Kay Copper Co. and demonstrated splendid chalcopyrite ore. In the same district, N. L. Amster, President of the Shannon Copper Co., is opening the Orizaba mine with success.

It will thus be seen that ore resembling the Jerome type and occurring in the same schist country-rock is found over a belt nearly 60 miles in length. The ore-bodies in the country south of Jerome are less lenticular in shape, and approach vein structure. They occur usually with the schistosity. Width of ore up to 40 ft. was found in the Blue Bell, but it is usually less. The greatest extent is normally in height, but several hundred feet in length has been demonstrated in quite a few cases. The ore follows laminated areas in the schist, which strikes slightly E. of N. and dips steeply west. Croppings are either quartz reefs, sometimes with copper stain, or soft laminated sericite schist, silvery white with yellowish iron-stain. Near Mayer magnetite breaks in with the ore and chalcopyrite is subordinate to pyrite; at the Kay copper mine and in that vicinity arsenopyrite is rather prominent, and pyrite disappears more and more. The grade of ore in this latter section is much higher.

Mines with complex sulphide ores are known in this copper belt near Mayer and link it with the old silver-gold mines of Crown King and the Bradshaw mountains.

Geographically, but not geologically, the Copper Basin district, west of Prescott, belongs to this area. From here the Commercial Mng. Co., a subsidiary of the Phelps Dodge Corporation, ships about 150 tons daily of 4% oxidized ore, which is used as flux at Humboldt and Clarkdale. The ore occurs in quartz monzonite. Large sections of the same rock are impregnated with pyrite and chalcopyrite, forming bodies of about 1·25% copper with additional values in gold, silver, and molybdenite. These have been prospected by the Loma Prieta and Copper Hill mining companies. I believe this district warrants more attention than heretofore. This grade of ore will be of economic value in the near future, if not now. The ore is strictly primary, chalcocitization is entirely lacking, and oxidation is as a rule very shallow. The deposit is probably of comparatively recent (Tertiary) origin.

THE CENTRAL AREA includes the Pinal Mountains district, Clifton-Morenci district, Tucson district, Dragoon Mountains, and Bisbee.

The greatest copper producer in the Southwest is the Pinal Mountains district. The Pinal mountains and their southern extension, the Mescal mountains, are a short range north of the Gila river, partly in Gila and partly in Pinal county, Arizona. Around these mountains in an area of less than 30 miles square are the mining towns of Globe, Inspiration, Miami, Superior, Ray, and Christmas. The following big mines are operating:

Inspiration Consolidated Copper Co., capacity 20,000 tons per day.

Ray Consolidated Copper Co., capacity 10,000 tons per day.

Miami Copper Co., capacity 5,000 to 6,000 tons per day.

Old Dominion Mining & Smelting Co., daily output about 1,500 tons but of considerably higher grade than the former.

Inspiration produces now at the rate of 11,000,000 lb. copper per month, and O.D., the smallest of the above, about 3,000,000 lb. per month.

Furthermore there are the medium-sized mines: Iron Cap (nearly 1,000,000 lb. per month) at Globe; Arizona Commercial, Globe; Magma at Superior; Arizona Hercules at Ray; Gila Copper Sulphide Co., operated by the American Smelting & Refining Co., at Christmas. And the smaller mines: Superior & Boston, New Dominion, and Gibson near Globe; Black Warrior near Inspiration; Grand Pacific at Superior; Gila Cañon Cons. and London Arizona near Hayden.

The total annual capacity of the district is over 350,000,000 lb. of copper. Three big smelters are operating: the International at Miami, the O.D. at Globe, and the A.S. & R. at Hayden. Concentration plants, all now using the flotation process, are at the Inspiration, Miami, O.D., Ray Con., Arizona Hercules, and Magma.

The production comes from three different types of deposits:

(1). Disseminated deposits; Inspiration, Miami, Ray Con., and Arizona Hercules.

(2). Vein deposits; O.D., Iron Cap, Arizona Commercial, Magma, and a great number of the smaller mines.

(3) Replacement in limestone; Gila Copper Sulphide, Gila Cañon Cons., and London Arizona.

The disseminated deposits have at present ore reserves aggregating 250,000,000 tons; about 60% of this in the Miami-Inspiration ore-body, and the balance in the Ray ore-body. Additions to this are still being developed. Present practice includes everything from 1% copper up as ore. The average grade mined is around 1·6%. Recovery varies from 70% to 90%; on very clean sulphide ore mill-runs will give a recovery in excess of 90%.

All the mines use underground methods of stoping, based on the principle of not trying to uphold the cap-rock, but to let it come down gradually and well regulated, and to use the crushing power of the incoming roof for comminution of the broken ore in the big stopes. A certain mingling of waste with the ore cannot be avoided in this way, and constant watch is kept on the run of chutes by sampling and observation of the issuing material. Uninterrupted mass-production at low cost and with minimum use of timber and powder are the goals aimed for. In actual practice there are considerable variations in the systems used by the different companies, especially in the preparatory work of getting the ore-run started and the pillars crushed.

The Clifton-Morenci District, though the oldest copper camp in Arizona, is far from senile. True the rich ore-bodies in limestone and shale have been nearly exhausted, but undaunted the operating companies changed from the mining of high-grade ore to that of low-grade and the profits from the latter have been greater and more persistent than from the former. It is very seldom realized that the Arizona Copper Co. Ltd. at Morenci was really the first company to operate a disseminated low-grade deposit in porphyry, before this same type assumed the tremendous importance which it holds now, but the ore was considerably higher in tenor than the average of the "Porphyries" and only recently has the grade of the Morenci ore been lowered to that of the other big companies. Incidentally this company was the first in the Southwest to try leaching of oxidized copper ores.

Three companies are operating in the district, all owning concentrating and smelting plants. These are:

The Arizona Copper Co. Ltd., a Scottish corporation.

The Detroit Copper Co., now Phelps Dodge Corporation, Morenci Branch.

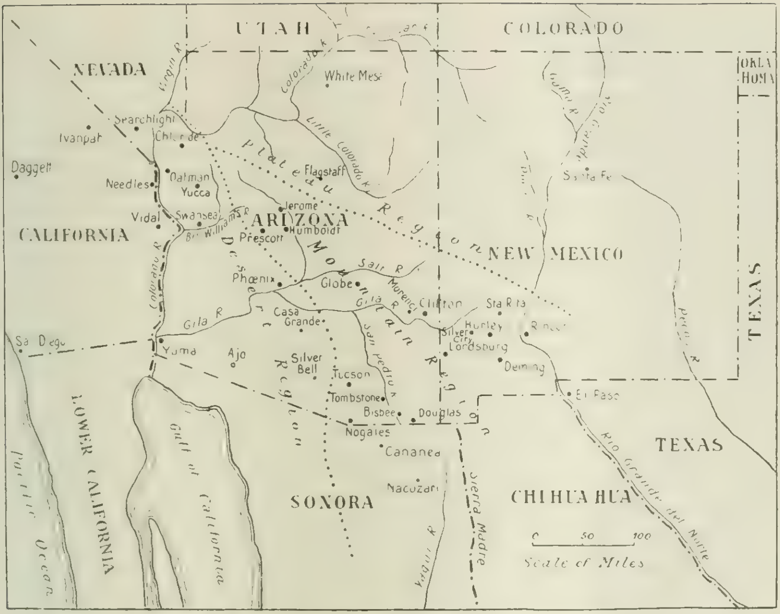
The Shannon Copper Co.

Of these the Arizona Copper is the most important. Norman Carmichael, its general manager, has brought the company to a very high efficiency by remodelling and enlarging the concentrator and building an excellent new smelter. P. B. Scotland, the mine superintendent, has introduced new and very cheap stoping methods, when such were needed and still regarded sceptically after the panic of 1907. The company owns the railroad from Hachita, N.M., (connecting with the El Paso & South Western System) to Lordsburg N.M. (connecting with the Southern Pacific R.R.) and on to Clifton. The daily capacity of mine and mill is from 4,500 to 5,000 tons, and the normal output is 50,000,000 lb. per year. The company is about the only one of the big operating companies in the Southwest which has not shown a tendency to branch out and acquire other properties here.

The Detroit Copper is feeling a gradual diminution of ore reserves, but is successfully lowering the grade of ore treated and therewith rendering available large blocks of ground, which were considered too low to be called ore only a few years ago. The production is between 15,000,000 lb. and 20,000,000 lb. copper per year. Milton H. McClean is general manager.

The Shannon Copper Co., N. L. Amster, President, and J. W. Bennie, general manager, is producing about 10,000,000 lb. of copper per year. The production used to be higher, but had shrunk considerably before the rise in price of copper. Mr. Amster is one of the men who rose from poverty to great wealth by a keen understanding of the mineral and mining possibilities of the Southwest. Globe was the field of his early operations and investments, and the Arizona Commercial Mng. Co. of that town was one of the enterprises fathered by him. Both the Shannon Copper Co. and Mr. Amster personally have for years, in anticipation of the ultimate exhaustion of the Shannon ores, embarked upon a vigorous campaign of expansion. The Leonard Copper Co. at Gleeson, Arizona, is one of the results of this campaign, and the Yager Canyon and Orizaba mines, mentioned in the northern area are gradually emerging from the prospecting stage. The R.R.R. mine near Patagonia and the Golconda near Kingman were for a time under this management, until a disinclination to pay royalties to the Minerals Separation company in the one case and a disastrous fire in the other put an end to steady and remunerative production.

The Clifton-Morenci district has been the scene of protracted and bitterly fought strikes



Map showing the Copper Regions of the Southwest.

during the last few years and its production has been badly impaired. The annual capacity of the district should be 80,000,000 lb. copper or more.

Around the old pueblo of Tucson, one of the earliest settlements in the southwestern United States, are a number of small but interesting copper districts. There are Twin Buttes, south of Tucson, mines in the Santa Catalina mountains, north of Tucson, and in the Santa Rita mountains east of the city. Mining is rather intermittent, but has received considerable impetus during the last few years. With the exception of the Camp Apache mines in the Santa Catalinas, owned by the Phelps Dodge Corporation but kept idle owing to difficulties of transportation, all properties are owned and operated by small companies or private individuals. Among the latter especially E.C. Bush and W. R. Ramsdell, both of Tucson, have furnished an example of how even in these days good judgment and true mining can lift a man from almost nothing to comfortable wealth.

All the copper mined in this section comes from contact metamorphic deposits in Paleozoic limestone. The annual production is close to 500,000,000 lb. The grade from 4% to 7%.

The Dragoon Mountains farther east have deposits of similar type. Several companies are operated steadily, but the district is less before the public eye than any other in Arizona. At the north end of the mountains at Johnson are the Arizona & Michigan Development Co., the Arizona United Co., and the Peabody Cons. Farther south are the Leonard at Gleason, and the Great Western and the Leadville at Courtland. The combined output is probably about 12,000 tons per month of from 4% to 5% ore. The Mascot Copper Co. in the Dos Cabegas mountains near Wilcox is of the same type. It was operated for a while by the A.S. & R. Co., but is now idle. Toward the Mexican border the R.R.R. mine near Patagonia keeps a 150 ton mill in steady operation and is shipping also straight smelting ore. Right at the border, east of Nogales, the Miami Copper Co. is shipping a small amount of 8% ore from the Santo Niño mine.

Bisbee, probably the most famous copper

camp in Arizona, is situated in the southeastern part of the State, eight miles from the Mexican border. The town, strung out along the two narrow canyons and their steep hillsides, used to be a typical ugly western mining camp, but several floods and one great fire initiated a change for the better. Now Warren, a few miles south on the open mesa, is the residence town with friendly houses and struggling gardens. The elevation is about 5,000 ft. above sea level. The country is dominated by limestone.

For a long time replacement bodies in limestone were the only source of copper, but now a disseminated ore-body in the porphyry of Sacramento hill has been added to the resources. Besides copper the district produces considerable lead, and recently manganese. From the bonanza days, when whole stopes assayed 30% copper, the grade has been lowered steadily, until now the average is round 5%. Sulphide ore is gaining the ascendency. The ore is found in great lenses, some originally lean and pyritic, others composed largely of bornite and chalcopyrite. The beautiful specimens of the oxidized copper minerals of the early days adorn probably every important mineral collection in the world. They have disappeared now from the underground workings, and everything spells well regulated machine-like precision and the narrowing margin between lowering grade and rising cost, quite a contrast with the glamour of early days, but intrinsically sounder and healthier. Thirty years ago 20% ore was low-grade; now ore as low as 2% is sent to the smelters. The output of the district is about 2,000,000 tons of ore per year, and the production over 200,000,000 lb. of copper. Under the stimulus of the War this rate was exceeded considerably.

Besides the Copper Queen and Calumet & Arizona, the two dominant companies, there are the Shattuck Arizona and the Denn Arizona, closely allied and under one management. Furthermore, there are the Higgins Lease and the Wolverine.

The ore horizon, which crops out on Higgins and Copper Queen ground, dips to the south, and the extension of the mineralized area has to contend with steadily increasing depth and heavy water flows. This made prospecting impossible except for well financed companies of ample means and steady determination, and has fostered the concentration of nearly all the promising ground in the hands of the two big companies.

The wages paid are the highest in the Southwest and vary with the price of copper. The maximum so far has been $6·10 per 8-hour shift to miners. The beneficial organizations are most advanced. Ore reserves for many years to come are blocked out and are being enlarged steadily.

The district has paid more in dividends than any other mining district in the Southwest, and and was one of the greatest factors in its development. The deepest shaft is only 1,800 ft. down. The Copper Queen has worked out cost tabulation to a very fine point. For every big stope charts are kept from which the minimum economic grade to be mined is fixed according to cost of operations and price of copper.

THE EASTERN AREA.—The principal mine in this area is that of the Chino Copper Co. at Santa Rita, New Mexico. John M. Sully is general manager. Copper was mined here by Mexicans as early as 1800, and primitive tools of that period, dug up in the present large-scale operations, are on exhibit in the company's office. The object of present-day mining is a body of disseminated low-grade ore in porphyry, rendered amendable to profitable exploitation by secondary enrichment. It occurs in a porphyry plug, the central core of which remains barren or nearly so. Oxidation is freakish and descends in some parts of the mine to great depth while it is shallow in others. The mine is worked by steam-shovels in deep open pits. The ore is hauled to the coarse crushing plant at the end of the pits, and from there to the concentrator at Hurley, six miles distant. The daily milling capacity is now 12,500 tons. Recovery was for a long time very low, 63% I believe, but is being improved steadily.

Next in importance is the Burro Mountains Copper Co., a branch of the Phelps Dodge Corporation. This company has gradually acquired the holdings of a number of adjoining companies and holds a very large territory of good promise. The proved ore reserves are small for a porphyry mine. The milling capacity is 1,200 to 1,500 tons per day, and the grade is slightly above 2%. Recovery was rather low, less than 70%, but has probably been improved. The mine is beautifully located at an elevation of over 6,000 ft. among tall pines, and the company has spent a large amount of money to make the camp a really artistic and model settlement. The mine is about 20 miles west of Chino.

South of the Burro mountains is the small town of Lordsburg, N.M. In its vicinity mining has been carried on for several decades, at first silver-mining, later copper. Now the

Eighty-five mine is the only producer of importance. It ships from 250 to 300 tons per day of low-grade very silicious ore, which is eagerly sought after for fluxing purposes.

Going east, mining is gradually waning. Prospecting near Stein's Pass, Deming, and Hachita has led to short-lived enterprises. There are only two districts north and northeast of El Paso which have merited more than passing attention; these are the Organ mountains district and the Sarilla-Orogrande district. Both are contact metamorphic belts in limestone and have produced at times considerable quantities of ore. They are now dead or nearly so, but might be revived.

THE SOUTHERN AREA.—This area, about corresponding to the State of Sonora, Mexico, has the two prominent copper districts of La Cananea and Nacozari, the former affiliated with the Cole-Ryan Calumet & Arizona interests, the latter a branch of the Phelps Dodge Corporation.

Cananea, after a spectacular career under its sponsor, the late Col. Wm. G. Greene, has settled down to a steady production of about 50,000,000 lb. copper per year. The concentrator and smelting works, long under the direct supervision of Dr. L. D. Ricketts, have been one of the factors for advancement of these applied sciences in the Southwest. The transition from high-grade ore to lower and lower grade was greatly emburdened by the political disturbances, which have shaken Mexico these last years.

The Moctezuma mine at Pilares de Nacozari is one of the most interesting copper deposits of the Southwest. Probably of Tertiary age, it shows a thoroughly brecciated rhyolite plug. The cement of the breccia contains rather coarse chalcopyrite, pyrite, and subordinate bornite. Chalcocitization was very shallow, but the mine shows splendid development in depth on strictly primary ore. Reserves of over 3,000,000 tons are kept steadily ahead of actual requirements. The grade is over 3%. At Nacozari, in a pretty canyon below the mine, is the concentrator of 2,000 tons daily capacity. The concentrates are smelted at Douglas, about 70 miles to the north. The mine has suffered also from the revolution, but to a less extent than Cananea.

Farther south in Sonora a number of copper prospects and mines are known, enough to promise a good future for this section and to indicate an extension of the great copper belt in this direction. But development has been retarded by the inaccessibility of the mountain fastnesses, from where only high-grade silver and gold ores could be shipped. Other sections less forbidding to transportation had been well advanced in mining activity, when the Mexican revolution put a stop to nearly every enterprise. As soon as Mexico settles down there will be a surprising activity and development in these parts, and hundreds of venturesome miners and operators are casting longing eyes from the grind and monotony of low-grade mining in the United States to the far green fields of Mexico with the supposed bonanzas, which only too often prove disappointing dreams.

TENDENCY OF COPPER MINING.—As is evident from the foregoing description the tendency of the Southwest has been from small high-grade mines to the development of great machine-like organizations utilizing lower and lower grade material. Fifteen years ago we used to shake our heads and wonder when we heard of the Lake Superior mines and their 1% ore. Now 1.5% ore mined by thousands and thousands of tons per day is an actual reality, while then 3.5% mill ore was awfully low. Smelting of less than 9% ore was considered impossible then. Now 5% ore is very good, and many mines make excellent profits; moreover, 4% ore and even 3% straight smelting ore yield good profits, while Bisbee holds the record with ore as low as 2%.

In the old days mines turned out a few tons per day for weeks, and then would strike another big shoot and rush up production to a few hundred tons per day. Now we have the mines that turn out the stipulated amount of ore every day with clock-like precision; some with several hundred tons daily production, others with several thousands, up to the wonderfully organized Inspiration mine, which holds the record with 21,000 tons per day. This development has stripped a good deal from the romance of mining, but for the steadily climbing output and dividend-receiving investors it has been a wonderful boon. Such it has been also for the mining population, which has changed from the care-free and spend-freely "hobo miner," who would drift north as far as British Columbia in summer and back to Arizona in winter, to steadily employed hard working men, very frequently married and owning their own homes and possibly a little garden or flower-patch. In the arid Southwest nothing is more gripping than the desire for things that are green and grow, and nothing so touching as the often awkward attempts to make things grow, where there seems to be not even a chance.

The possibilities of starting out and finding a bonanza, to grow rich over night are gone.

All the easily recognizable mines have been found. The days of the prospector of old are over. What prospecting is left is being based more and more on detailed geological study, and requires usually a great deal of expensive development work and ample financial backing. Probably most of the big deposits have been found. While of late the tendency has been from bigger to bigger organizations, I believe that of necessity the tendency will be reversed in the future and that the small mine will become a factor of increasing importance.

Up to now mining has been the greatest factor in bringing railroads and developing transport; henceforth other industries will probably extend the railroad network and in their turn render mining possible.

Up to recent years wages varied very much in the different camps; also working hours, organization, and standards. Now the greater part of the Southwest has the uniform eight-hour bank to bank work-day, steadily increasing supervision, regulation, and sanitation, and the sliding scale of wages, regulated by the price of copper. Accident liability is regulated by law.

True there are still great differences in the basal rate of pay, but these are being reduced more and more.

Formerly, there were strictly "white-man's camps" and "Mexican camps," the latter receiving about one half to two-thirds the pay of the former. This still survives to some extent, but unification of labour is progressing rapidly, and in many camps both nationalities mingle freely on an even rate of pay. Bisbee, I believe, is the only camp where the rule "no Mexican labour underground" is strictly upheld.

The miners are of many nationalities. Native-born Americans are comparatively few. A large proportion are English subjects, nearly as many Jugo-Slavs, especially from Bosnia, Herzegovina, and Dalmatia, a good many Italians and Spaniards, the latter especially in the Mexican camps, and a few scattered Greeks. Scandinavians and Finlanders are numerous in certain camps, but they are not as widespread as the other nationalities, and do not seem to like the southern camps as well as those farther north, as in Colorado and Utah.

THE "PORPHYRIES."—No other single agency has exerted such great influence upon the copper industry of the Southwest as the advent of the "Porphyries." They revolutionized mining methods, advanced concentration, and changed smelting practice. How great is their share in the present production is evident from an enumeration of the mines which come under this heading: Inspiration, Miami, Ray Consolidated, Arizona Hercules, the Clifton-Morenci district, the Chino Copper Co., Burro Mountains, Ajo, and Sacramento Hill at Bisbee. Very closely related also is Nacozari. Roughly their combined daily output is 65,000 tons and their annual production over 500,000,000 lb. The only one which is not yet in active operation is Sacramento Hill, but steam-shovels are removing the cap-rock and the mill is under construction. Of the above only two have ore-bodies of primary ore: Nacozari and Ajo; the latter is the only one which utilizes also large bodies of oxidized ore. Primary ore enters also to some extent into the calculated ore reserves of the Arizona Hercules. But the balance owe their existence only to a long extended and tedious process of concentration, in which Nature has collected widely distributed minute particles of copper and joined them in a horizon of secondary enrichment in the form of chalcocite.

Though conscious of the danger of repeating something that is long since public knowledge, I wish to give a brief description of this type. The mines are found in fractured and altered porphyry or schist. The primary mineralization consists of pyrite with admixture of chalcopyrite. This is disseminated through the mass of the rock, deposited along cleavage and fracture planes, and forms irregular little veinlets and seams. Primary material hardly ever exceeds 0·5% copper and has no economic value. Silicification and sericitization went hand in hand with the pyritization. The silicification is shown as well in a network of narrow quartz seams as in general induration. Secondary processes are kaolinization, the dissolution of the chalcopyrite molecule, its transportation downward in the form of sulphate and re-deposition upon precipitating sulphides below, which it replaces gradually, forming chalcocite. In the upper part of the chalcocite horizon this replacement is complete, in the lower part partial, and ultimately it shows only as a slight coating and penetration along cracks.

The iron in the leached zone oxidizes and stains the outcrops red and yellow. Quartz-reefs stand out sometimes, their faces stained green with copper salts. The oxidized horizon is partly barren, and partly retains copper in oxidized form, the latter especially close to the chalcocite horizon. This is one reason why recovery is often very low in treating semi-oxidized ores, as the greater part of the copper in oxidized form goes into the tailings. The chalcocite horizon resembles a bed, above which is the barren oxidized material or cap-rock, and below the valueless primary material. The cap-rock in most mines varies from 150 ft. to 500 ft. in thickness, but abnormally great thicknesses are known. The chalcocite horizon is around 300 ft. average, varying from 75 ft. to over 500 feet.

Large sections of this ore will assay well above 2% and even 3%. The bigger mines in present practice include everything down to 1% in the ore reserves, but their average grade is around 1·75%. Smaller mines have to keep their grade above 2%.

The ore is mined either by underground methods or, where feasible, by stripping the cap-rock and mining the ore by steam-shovel in great open pits. Such steam-shovel mines are Chino, Ajo, and Sacramento Hill. The steam-shovel method is cheaper and gives cleaner ore, and the grade mineable in this way can therefore be slightly lower than in the underground mines. But remarkably low underground mining costs have been attained. Inspiration with 60c. per ton holds the record here. Of course success with such low-grade material depends upon mass output, cheapness, and clockwork-like precision.

The underground haulage is on 40 lb. or 60 lb. rails, and the power either electric or compressed-air locomotives. Hoisting is done from great storage pockets, usually concreted, with automatic lock-gates. The ore is hoisted mostly through concreted shafts in self-dumping skips of from 3 tons to 8 tons capacity. Coarse ore-bins are of reinforced concrete, and the coarse-crushing plants are usually near the main hoisting shaft. Below are the storage bins, huge houses of reinforced concrete, from which the broken ore is transported to the mills by railroad trains or conveyor-belts.

Concentration is an important factor in the treatment of porphyry ore. Water-concentration has practically given way to the flotation process. Stage crushing is the general practice, firstly gyratory crushers and the different sets of rolls, with sometimes jaw-crushers, instead of coarse rolls, ultimately ball-mills, Chilean mills, or Marathon mills. Pebbles for crushing are going more and more out of use.

For flotation machinery the Minerals Separation Co.'s apparatus, the Callow cell, and the K & K flotation machine are mostly used. The last-named was invented and perfected in the Southwest and has its name from the inventors, Messrs. Kraut and Kollberg, formerly of Bisbee. Headquarters for this machine is now the Southwestern Engineering Co. of Los Angeles, Cal.

SMELTING.—The steadily increasing amount of the fine flotation concentrate hastened the change from blast-furnace to reverberatory. The latter was unknown in the Southwest a few years ago, now all the great smelters have both, with ever-increasing preponderance of the reverberatory in new construction. Coke is probably at present the predominant fuel, oil has been tried, but coal-dust seems to be the fuel of the future. Mechanical appliances such as mechanical roasters, automatic weighing and charging, and electric travelling cranes for lifting heavy masses are eliminating the expensive hand-work of earlier days. In converting, the change from silicious to basic lining is universal, and larger and larger converter-shells are coming into use.

Steam is still used largely, and in up-to-date plants the steam-turbine is employed. But the internal combustion engine is gaining more ground daily. The smaller mines depend upon it almost entirely. Gasolene is used more in these than crude oil. For boiler fuel crude oil is gaining on coal. The Calumet & Arizona utilizes waste-gases from its smelter for power generation, which is transmitted electrically. The Inspiration and Magma buy electricity from the water-power plant at the Roosevelt Dam.

CONCLUSION.—The old days of wastefulness and happy-go-lucky mining are gone. Nothing has been of greater benefit in reducing costs and improving management than the black days of the copper industry. The older generation still dates the most incisive changes from the "panic of 1907," when copper, after climbing steadily up to 26c., dropped overnight to 11c. For years thereafter the copper market hung around 12c. and 13c. and kept managers busy to reduce costs and evolve system, to combine a low market price with steadily rising wages and cost of supplies. The copper market was just beginning to improve, when the war in 1914 caused the bottom to drop out of it temporarily, only to introduce later the most phenomenal rise in copper prices that the world has seen, soon followed by a similar rise in all other commodities.

From 1907 dates the general change from the old expensive square-set mining, which was universal in the Southwest until then, to cheaper mining methods with reduction in the use of timber. Cut-and-fill, shrinkage, and block-caving are employed in massive ore-bodies, and grade into the mass-crushing methods employed by the porphyries. Strictest supervision is employed in the use of powder, and tamping is becoming general practice. Mechanical drill-sharpeners have displaced the old-time blacksmith, and the air-drill the hammer-miner. In rock-drills the discarding of the old piston machine is complete. Light one-man machines take the place of the cumbersome two-man machines, and other light hammer-drills do nearly all the stope-work. Winding machines of less than 200 lb. weight displace the windlass in winzes, and up-to-date pulleys facilitate the work in rises. Mechanical ventilation is coming into general use, and the stopes where men could not stay without having the sweat pour off them, the dreaded try-out places for new-comers, are almost legendary.

Another waste, really more important than that of material, that of human life and health, did not find as early attention as other misuses, but now most companies make up for lost time, and very liberal legislation in the progressive mining states works in the same direction. Medical inspection, first-aid instruction, excellent sickness and accident regulations are spreading all over the Southwest. Well ventilated and heated change-houses with locker for the employees' clothes and drys for the digging clothes, with shower-baths and washstands, are prescribed by law and the companies take pride to compete with each other in such things as these. Accident prevention and safety-first instruction came into being at the same time with the much ridiculed efficiency engineer. Clubhouses with libraries, billiard tables, lawn tennis courts, and other social institutions are found frequently, and the companies try hard enough to start a feeling of fellowship between officials and workmen. Of course many of these innovations are more a testing and feeling out. The gap between capital and labour is still a wide one, and frequent clashes of the class-spirit are demonstrated in strikes and shutdowns.

We are living in an age of transition, and the great gap created by the rapid world-wide change from agriculture to industrialism is as yet hard to bridge. How the world-shaking events of these last years will influence this problem of humanity is impossible to predict, but I personally believe that the post-war period of reconstruction and re-arrangement will bring a tremendous advance in all social endeavour and will help to level many an unevenness in the social structure.

FOUR YEARS AS A PRISONER OF WAR

By J. C. FARRANT.

(Continued from the May issue, page 287).

The author continues his account of the treatment of Prisoners of War sent by the Germans to Kurland, Russia.

May 28, 1916. This was Sunday. Uhlans turned every man out at 4.30 a.m. After a cup of coffee the men were marched to the forest where they were employed felling trees. At night, after coffee was served, the whole camp was put through a saluting parade, all this on two drinks of coffee and three slices of bread $\frac{3}{4}$ in. thick. The soup served at midday was nothing but a drink. The Uhlans left next day. A rumour went round the camp that parcels were on the way, but it was another ten days before they actually arrived, and then only a few. The parcels were individually addressed. Those who received parcels were lucky; those who did not went without. Until parcels arrived, nettles, oats, and wheat were boiled and eaten. A few sheaves of corn were found in a barn. The ears were broken off, and were put in a handkerchief, and beaten on a stone to liberate the grains. A good deal of stomach trouble was caused through eating partly boiled oats, but it was a case of "What won't fatten will fill." The mosquitoes in this place gave us no rest day or night. It was a case of either sleeping with one's head under the blanket, or walking about the lager most of the night.

June 4. Every man was inoculated. Quite a number of men went down and out after the operation. We were all very weak owing to insufficient nourishment.

June 6. Some parcels arrived. A week later the German rations were cut down by 25%. A note to the American Ambassador was written by our N.C.O.'s complaining about our rations being reduced. This did not get past the officer, who, however, promised us the full amount of rations allowed.

June 15. A heavy rainstorm. All the barns leaked and the turf kennels that some of the men had built were washed away, the men who had occupied them coming into the already overcrowded barns. This rain seriously affected the roads. The German transport was unable to get to the camp from Zeren station for two days, so our rations were reduced by half; but it was noticed that no difference was made in the rations the German guards drew. The short rations were never made up, on any of the many occasions, although frequent promises were made to do so. The hospital was full, mostly with men who had dropped from exhaustion while at work.

July 8. Sentry struck one of our men, who struck him back. The Englishman was taken to the guard's house, being man-handled on the way, and put in cells; he got 12 months-imprisonment subsequently.

July 9. Several men who had committed offences in Germany and who had been sent to Russia before their term of punishment was finished were, by an order from their lager kommandant, to complete their punishment here. It was unfortunate that this order should have come after the striking incident of yesterday as the following will show.

Six men were taken to the forest just outside the lager and were made to stand on blocks of wood with their backs to trees, to which they were then lashed and the blocks kicked away. In one case a man (Mc Quitty of the Canadians) was suspended by his arms. He and a soldier called Mason made sworn statements concerning their treatment. These statements were taken down by one of our N.C.O.'s and handed in to the officer commanding, who replied that the matter would be inquired into. Mason, who fainted after he was untied, had been previously excused all work by the German doctor as he was physically unfit. The guards who tied the men up in this fashion told them it was on account of one of our men striking a guard.

July 10. No soap in the camp, and none had been issued by the Germans for months. Inoculated again. There was no recreation in this camp, and work had to be done every Sunday.

July 14. The whole camp was given two hours in which to pack their gear. We fell in at 1 p.m. and marched 12 kilometres to a place called Plauven. The next day we 600 were medically inspected by a divisional doctor, who felt every man's biceps, singling out the heavy men. Each man received one loaf of German war bread, which was to last four days. Several men ate their loaf as soon as they received it.

July 16. Raining in torrents. Parading in open field at 4 a.m., we were split up into several parties, each party going a separate way. Our party was told off to draw a field cooker. We piled our packs on top and lugged this load through the mud and rain for 17 kilometres, arriving at Talsen at 7.30 p.m. We were wet through and dog tired. Most of the other parties went on farming kommandos or loading and unloading provisions on the line.

I was employed on the parcel staff. The parcels for which we had waited so long were at Zeren on the railway some distance away. We arrived at Zeren on the 20th. The parcels had been stored in a shed by the track. We started in to sort the parcels, prior to sending them by wagon to the various kommandos. All the bread, some 3,000 loaves, was bad, too bad for a prisoner of war to eat. The once lovely white Danish bread was black, green, and yellow. As may be imagined, this was a bitter disappointment.

Sleep here, as at Kilizeem, was almost impossible. It was too hot to sleep with one's head under the blankets, and the mosquitoes were hell. We had only been in this shed one night when we found the place was alive with vermin, but as there was an ants' nest near by, we were able to keep pretty clear of vermin by leaving our shirts on the ant heaps while we wrapped ourselves in blankets. Ants are death on vermin. What we didn't find was something to eat both the ants and the mosquitoes.

July 30. Moved to Stenden, which was to be the headquarters for all the kommandos in this part of Kurland.

As far as I was concerned, I had a comparatively quiet time for the next four months. There were only six of us, and we were engaged in sorting letters and parcels. The men on the farms had a pretty hard time of it, working from 5.30 in the morning till 8 p.m.; but as there was more or less food to be had the life was considerably easier than at Kilizeem.

August 31. A. J. Picton Warlow and J. Nowland of the R.N.D. were recaptured after escaping from their kommando. Their idea was to get to the coast, make rafts, and try to cross the bay into Riga. They received 14 days.

The nights were now drawing in, but no lights were supplied by the Germans. We bribed a transport driver to get us candles at 1 mark each.

September 29. Ordered to pack up. Four of us loaded all the parcels in a railway wagon and travelled by rail to Libau. Arriving at Libau on October 3, four of us, with a German guard, went up to the English lager where the other 1,000 Englishmen had gone when they left Germany. On our way up we passed a company of about 200 of our men swinging down the road in great style. It was a good sight, and German soldiers and Russian civilians stopped to see them go by. Every man was spick and span, cap badges and buttons shone like silver, all "chucking a chest" and marching in step. These "old contemptibles" made a fine advertisement for the British Empire. It didn't take us long to find the reason for this extra smart appearance. These men were working at the docks, and so were some 2,000 Lettish girls. When our boys first made their appearance in Libau in May, the girls working on the docks dressed mostly in sacks and wooden clogs, and were known by the men as "donkeys," as they were employed generally in pulling carts about; but it was not very long before each sex started smartening up in appearance, and when I went to the docks in October the "donkeys" wore shoes and stockings with generally a very English-looking red handkerchief tied round their heads, while they had discarded the sacks for something smarter.

Conversation was "streng verboten" between the Lettish girls and our men. It can be imagined how much effect that order had. Each man more or less had his special "donkey," and used to take her chocolate when he got it in his parcel, and she in return would occasionally half hitch a bottle of rum for him.

It was hard work on the docks, but I never knew a party that wanted to leave Libau and the "donkeys." The work for our men consisted of loading and unloading provisions.

There were two main docks, "North West" and "Winterhaven." The former are the larger, being four stories high. Salt and sugar weighed 240 lb. per sack, flour weighed 180 lb., and oats 150 lb. Carrying a 240 lb. sack on one's back from the ship's side into the store and up four flights is no child's play, and several men became ruptured by slipping with this weight on their backs. The men were given tasks, so many sacks and finish; it usually meant working seven hours daily. Working parties were also sent to the "fischerei" and slaughter house.

It goes without saying that men at Libau were seldom hungry, though parties were searched at the docks, and again in the lager. Secreting foodstuff became an art, at which the Lettish girls were not far behind our men. Their favourite ruse was to dampen the flour and make a thick paste and lay a good sized cake on either shoulder under their blouses.

I remember one night I was standing inside the gate as a party of our men came into camp, when they were halted and searched by a German N.C.O. Nothing was found, and the party was marching on, when the N.C.O. noticed an onion drop from a man's coat. He ordered him to halt. As he did so, a stream of onions ran out from his overcoat sleeve. He had slit the lining and filled his sleeve up, but unfortunately the lining was old. He got seven days in consequence.

On another occasion a most vigorous search was made, but not a thing was found. It really was amusing to see the men unload when they were out of sight of the guards; slabs of raw meat, and small bags of flour and sugar were hauled out from most uncanny places. Sergeant Pinchen of the Manchesters afforded the best laugh when asked if he had "got away" with anything. His answer was to take off his woollen scarf, which was twisted round his neck, and throw it on the table. There before our gaze lay a string of twelve prime sausages which had been enfolded in his scarf. That's how it was done at Libau.

Every one used to make pancakes or "Gepatties" as we called them, from the flour that had been purloined from the docks.

Our men were occasionally called upon to unload rum. The result was always the same, trouble all round and bad heads for a couple of days. After such an occasion each man swore he'd never touch the stuff again, and he didn't till the next rum boat came alongside.

October 4. I went with four others to Hasenporth, a town about 60 kilometres from Libau, where we were engaged upon sorting and despatching parcels. We had plenty of work, but it was a very good number, and matters ran along smoothly with us for two months until a new guard turned up. He complained that the house in which we lived was too cold, and that he should get another at the other end of the town. This didn't suit us at all, as we had become familiar with some of the Lettish people near by who sold us eggs and vegetables, and were very good to us in many ways. One night the new guard announced that we would move the next day. A heated argument then arose between us and the guard, in which personal abuse figured largely. After the "spasm" was over, he telephoned to the kommandant, who ordered our immediate removal.

December 11. We five marched to Rochaishen, 5 kilometres away, where some 150 of our men were housed in a barn. There was only a mud floor and no fire. It was a miserable place. We stayed here till the day after Christmas. On Christmas day I turned in at 7 p.m., as it was impossible to keep warm. We tried to build a fire in a cut-off portion of the barn which we occupied, but as there was no means of getting rid of the smoke we had to give up the idea.

December 26. All the men on this kommando were ordered to pack up and move to a new lager, to which all the other parties in this district were to reassemble. We left Rochaishen at 6.30 a.m. travelling light, and reached Erbsen Krug at 6.30 p.m., having marched 37 kilometres through six inches of snow in twelve hours. The next few days were spent in making up the different working parties.

Our new abode was a brick schoolhouse with about a dozen rooms. In each room three tiers of shelves were built, upon which we slept. The distance between the shelves was the height of a man sitting down. There were no partitions, and as many men as possible were crowded on each shelf. It was truly a case of "when father said 'turn' we all turned." It was very cold outside and no windows were open. Consequently the atmosphere became very thick and hot inside owing to the overcrowding.

(To be continued).

NEWS LETTERS.

CAMBORNE.

GEEVOR.—This mine continues to open up very satisfactorily, and can now claim to be the fourth largest producer of black tin in Cornwall. From an official return, it appears that for the eight weeks ended May 21 last, 4,322 tons of ore was milled from which was produced 71 tons of black tin, having a value of approximately £8,710. This is equivalent to an average recovery of 36 lb. per ton of ore milled. With a better price for tin, and with the fore-shadowed enlarged milling capacity, the company should earn handsome profits. The mine has recently been inspected by Mr. J. M. Iles, and his report will shortly be made public.

DOLCOATH.—A distinctly encouraging discovery of ore, much above the present average produce from the mine, has been made in the drive at the 352 fm. level west of the Stray Park shaft. This drive was being prosecuted with a view to the intersection of an extension of the fairly good shoot of tin which was worked in the old Camborne Vean mine. The official circular dated May 28 gave the average value of the lode in the drive as 47 lb. black tin per ton, but no width was given. I have reason to believe the average value has since substantially improved. The jump in the price of the shares (about 6s. per share, or say £105,000 in all) is by no means justified at this stage, in view of the limited amount of good ground so far opened up. If the cross-cut from the 375 fm. level also intersects good values, the prospect of opening up a substantial block of ore in this section of the mine will be more tangible. Every well-wisher of Cornish mining will watch this development with more than ordinary interest and the hope that, at last, a new ore-body of value has been located, for success at Dolcoath will react on the whole industry.

LEVANT.—Although for the four months ended May 3 last a loss of £3,273 is shown in the statement of account issued, this is more apparent than real, because the ore broken in new stopes by men returning from the war had largely to be left underground, seeing that the system of over-hand stoping in use necessitates a large accumulation of ore for the men to work on. The most satisfactory feature revealed by the report is that the average recovery for the period in question was slightly over 55 lb. per ton. The tonnage milled was 4,427, and the black tin sold amounted to 110 tons. But for the serious fall of nearly £47 per ton in the realized price for tin, a very handsome profit would obviously have been earned. However, it is fortunate that the management have such good ore to fall back on in these difficult times. The submarine section of the mine was re-opened in the belief that a large number of Levant men serving with the Forces would be demobilized and available; the number released, however, has proved much below expectations, and only about 50 men are available for the submarine section against a normal number of 200. The cost of ventilating these hot workings is not justified on so small a working force, and it seems probable that work there will again be abandoned and the men utilized in the upper levels where such splendid values are being obtained. The satisfactory results obtained at Geevor on the Levant series of lodes has evidently decided the management on a reconsideration of the position of the inland section of Levant. Hitherto, little development has been done in this direction, because it was found that the lodes, which were highly payable in the killas, were pinched and poor when in the granite, the junction of which is near the cliffs. It is now believed that outside the zone of hard burnt-up granite which adjoins the killas, the lodes will resume their normal width and value, and this theory will doubtless now be tested. An examination of the district by a good geologist should well repay the expense, and it is surprising that this course has not been suggested. A call of 10s. per share, which will realize £1,250, was made to partly meet the loss made. The question of converting the company into one of limited liability is under discussion.

GOVERNMENT AID FOR THE TIN MINING INDUSTRY.—The Joint Industrial Council are still pressing for financial aid for the industry from the Government, and while we admire their perseverance, we have little faith that the Treasury will give way, unless under direct orders from the War Cabinet. The member of Parliament for the Mining Division (Mr. F. D. Acland) has now been asked by the Council to try to get the matter re-opened; when he offered to help some months ago his co-operation was refused, but fortunately he appears to harbour no resentment, and has agreed to act as a forlorn hope. The most hopeful feature of the whole business is that members of Parliament are at last beginning to realize the wastefulness of the out-of-work donation, and that such money— in the case of this industry and many others—could be used to better advantage if given in the shape of subsidies or grants to the employers. Mr. Clynes, one of the most intelligent and level-headed of the Labour members, suggested in a recent discussion in Parliament on this subject that it would be wiser to adopt the policy of subsidizing industries rather than to leave the men so much to chance, as was the case at present. The trouble is that by the time this common-sense suggestion has penetrated the minds of the permanent officials of the Ministry of Labour and the Treasury, the mines in Cornwall which need assistance will be beyond such aid.

Tin Concentrate Output for 1918.—The Home Office figures show that the output for Cornwall and Devon for last year was 5,376 tons, as compared with 5,262 tons for the previous year. This increase was principally due to the abnormal production from East Pool & Agar.

Arsenic Production for 1918.—The production of Cornwall and Devon for last year shows a falling off, in spite of the high price for this product, only 2,225 tons being produced against 2,574 tons for 1917.

NORTH OF ENGLAND.

The Mining Position.—The position of affairs was put very bluntly and very clearly before Sir Auckland Geddes, the new President of the Board of Trade, by the Industrial Council of the Lead, Zinc, and Barytes Association, at an interview on May 29, and there is a chance that his answer to the representations which were made to him may be forthcoming in time for publication in the current issue. The President learnt from the spokesmen of the Council, which was introduced by Mr. Wignell, M.P., some of the earlier history of the lead industry. He was shown how for 25 years following 1884 the average price of lead ruled below £13, and how nearly the industry came to be killed during this long period of low prices. A great many of the properties became water-logged, capital was permanently alienated, and even the high prices realized subsequently failed to induce capitalists to regard British lead mining as a legitimate form of investment. The output of lead for three years before the war was practically stationary, but then consumption rose steadily, and with the mounting of prices a more favourable atmosphere was created. It is true that the price of £29 per ton fixed by the Government for lead early in the war—a figure which ruled until the end of 1918—was a considerable increase on pre-war prices, but any benefit to the producer was more than absorbed by simultaneous rises in the cost of labour and material. And, moreover, the increased price fell short of that which would have been obtained in a free market, and was, in actual fact, lower than the price of £40 at which during many months the Government were purchasing their whole supplies of lead from America. In this way discrimination was exercised against the British producer.

As to zinc ore, the price rose to a very high level during the early part of the war, but the home producer derived no benefit owing to the fact that the market was overstocked with zinc ore from the capture and sale at nominal prices of prize cargoes of zinc ore *en route* to Germany. From the beginning almost in 1917 the price of zinc was rigidly controlled by the Government, which made arrangements to supply the smelters with the whole of their requirements of ore, principally from Australia. By this time the cost of smelting had increased so enormously that smelters were unable to pay the home producer a price in any way corresponding to the enhanced price of metal. At the present time, owing to the accumulated stocks, the world's price of zinc has fallen to a figure which is no longer remunerative to the great bulk of producers in any country. The prospects of any rise for some time to come are not cheerful, because of the menace of the accumulated stocks and of the temporary cessation of demand for commercial purposes. After deducting from the market price the present abnormal cost of converting the ore into metal, the margin left for the producer of the ore is entirely insufficient to meet his cost of production. Unless, therefore, something is done, and done immediately, there is no possible alternative but for the mines to close down; and in mining, it is scarcely necessary to point out, a temporary suspension of operations generally involves a permanent abandonment. If the bonus which has been paid ceases on June 30 most of the mines will then suspend operations. It is to be hoped that Sir Auckland Geddes will be able to prevail upon the War Cabinet, before whom he will lay the case put before him, to continue the payment of the bonus until the Government has had time to make a thorough investigation of the position.

Regarding barytes, owing to artificial conditions brought about by the war, the barytes industry has been enabled to make up to a very large extent for the shortage of supplies brought about by the stoppage of imports for Germany. A free market has resulted in a substantial expansion of the industry which can be maintained if the producing companies are assured of stable working conditions.

A further fact that has prejudiced the mines is the application to lead, zinc, and barytes miners of the wages bonuses known as the Coal Controller's awards, and in addition the Unions are now claiming the equivalent of the Sankey award which involves a further increased wage and reduced hours of working. The Government agreed to refund the bonuses payable under the extension of the Coal Controller's award up to March 31, but in regard to barytes, the Government disclaims liability for payment of the second award, and has definitely refused to refund amounts which the companies have already paid over. The deputation requested the Government to appoint immediately a commission of inquiry, and, pending this, that the existing bonuses on output should be extended on the present basis, and that the re-fund of the wages award already made and of all or any that may hereafter be extended to the non-ferrous mining industry should be continued.

The workmen's representatives are equally of opinion that unless the Government guarantees the existing war wages so long as the Wages Act is in operation, there seems to be no alternative but the destruction of the industries. They pointed out that a large number of the men live on small crofts or farms, and are settled on the soil or live in village communities, so that it would be very difficult to transfer the workmen into any other industries. They would be thrown upon the Government unemployment grant, and the cost to the Government would in that case be more than what the subsidy per man now amounts to. It seems to the workmen that if the mines are not immediately closed, the owners will take steps to get out of the mines all the ore in sight and render it impossible for many years for the industry to be re-opened on a commercial basis. Or, if the mines are not immediately exploited, all development work will be curtailed, thus bringing the industry in time to a total stoppage.

Sir Auckland Geddes said the matter had already been before the War Cabinet, and that it was engaging the closest attention of the Government. He referred of course to the very heavy claims on the Exchequer, but he quite realized the seriousness of the situation and he hoped to let the Council have a reply in the course of a few days. If the answer is unfavourable, the only step open is to ventilate the grievances of the industry in the Press and in Parliament.

LEAD.—Steps are being taken to explore and open out the lodes on the Caldbeck Fells. These include the Roughtenghyll mines and the Driggeth mines, both of which were worked on a large scale before their abandonment between 1860 and 1870. The blende in the lodes was in all cases treated as waste, but there are large deposits of barytes ; and with the new methods of treatment by oil flotation it should be possible to handle this proposition on modern lines and to market lead, blende, and barytes instead of merely the lead as in the old days.

Up to quite recently the lead ore produced at Greenside and Weardale has been smelted on the spot. In both these cases it has been decided to sell the products as galena owing to the difficulty of conducting the operation as cheaply as can the smelters.

I understand that the deposit found at Threlkeld is rather improving. It looks as though this company is at last going to have a new lease of life. There are about 40 fathoms of payable lode of galena and blende opened out at the present time, with a possibility of 1,500 ft. of backs.

BARYTES.—The barytes market is still very strong ; £13 is readily obtained for good quality barytes, and £7 to £8 for the discoloured grades. At the moment there are no import restrictions regarding this material, but there is a possibility of their being imposed on July 1.

I hear that the Longfell Barytes Company, near Appleby, is likely to be a producer of barytes on a fairly large scale at an early date. The ropeway from the mine to the present plant is completed, the distance being about a mile and a half. The plant is well advanced and the company will be able to turn out a good deal of ground barytes, equal to the best German pre-war quality. I hear also that the company has acquired the Silver Band mine which many years ago was worked by the London Lead Company.

GYPSUM.—In the Appleby valley there is a considerable deposit of gypsum with ten to twenty feet of soil over it, which is now being worked by several companies. Some well designed and up-to-date plant has been laid down for the treatment of the rock. The over-burden on the gypsum is being excavated by a powerful steam shovel. The bed is about twelve to fourteen feet thick. Prices are thoroughly remunerative, and when the national programme of housing is under way there is little doubt that the whole output will be readily absorbed.

PERTH, W.A.

April 4.

POTASH MINERALS.—The Magazine will have already published information relating to the investigations of potash-bearing deposits in West Australia. The Government Geologists have recently been making extensive inquiries, and have just issued their report, from which the following information is taken.

Alunite is found in Kanowna district and also at Northampton, and efforts are being made to open up the former.

Glauconite, a hydrous silicate of iron and potassium, carrying about 7½% of potash, is found at Gingin. An almost horizontal bed of glauconite sand (green sand) over 30 ft. thick has been proved to exist under a thin cover of chalk. This sand is a mixture of quartz and glauconite with a little calcite. At this point therefore there appears to be a large tonnage of green sand, but of a low grade, namely, £2. 10s. worth of potash per ton at the assumed rate of 20s. per unit. This is the only point from which samples have been collected, though there is a large area hereabouts of similar beds, portions of which may well carry more glauconite and less quartz, and therefore be richer in potash. The whole of the potash in glauconite is readily soluble in standard hydrochloric acid, so that wherever it occurs as a normal constituent of the soils its potash would be considered as available for plant food. There is evidence also that glauconite decomposes fairly rapidly in soils which are not markedly alkaline. In the absence of all supplies of potash this mineral is well worth trying in its raw condition, or better still mixed with superphosphate, on the south-western lands. Its utilization on any large scale will, however, depend on the possibility of discovering a cheap mechanical process of concentration to increase the grade of the ore before chemical treatment.

Jarosite is a hydrous sulphate of iron and potassium; but all natural jarosites contain some sodium. It is always a possible source of potash, but has not previously been suggested as a source of potash, perhaps because it has been looked upon as a rare mineral. In West Australia these minerals occur in several localities, Kundip, Upper Kalgan River, Comet Vale, Northampton, and Nullagine. In one locality, Northampton, jarosite and highly potassic natrojarosite are somewhat widely distributed and appear to be in sufficient quantities to warrant exploitation. Commercially valuable potash salts can be extracted from jarosite at a very small cost, and with a very high percentage of extraction.

Already a preliminary attempt has been made to work the Northampton deposits on a commercial scale. In this district the minerals occur at and near the surface in lodes usually associated with graphite. The lodes appear to be shear zones in gneissic granite, the mineral arising from interaction between weathering pyrite and the potash-bearing silicates of the rock. Typical analyses show contents of potash varying from 2·16 to 5·78%. A lower-grade lode with graphite was found a mile south of Northampton. On the Upper Kalgan River a jarosite deposit has been found, but nothing is yet known regarding its extent. Natrojarosite very poor in potash has been found at Kundip, but the district should certainly be prospected for higher-grade mineral.

TORONTO.

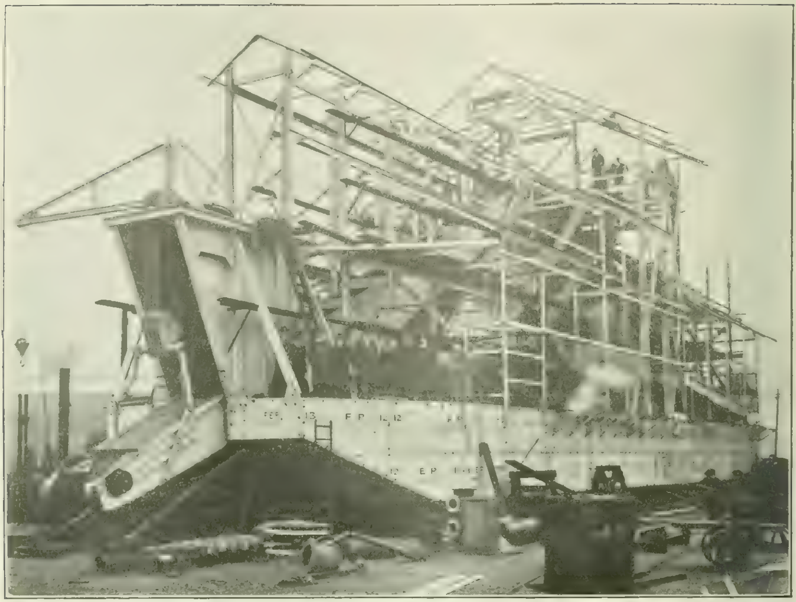
May 12.

PORCUPINE.—The Hollinger Consolidated bids fair to make a new high record of production during the current year. A statement covering the first 12 weeks of 1919 shows a total income of $1,358,980. The mill treated 138,260 tons of ore of the average value of $9·78 per ton. Since this report was issued, the entire milling plant has been put into operation, handling about 2,640 tons per day. There are now some 1,300 employees on the pay-roll, and the management is desirous of taking on a few hundred more, but is at present unable to do so owing to the lack of adequate housing accommodation. The town of Timmins is at present full to overflowing, and the building now in progress is inadequate to supply the demand for houses. The mill of the Dome Mines resumed operations last week on a limited scale, which will be increased until 1,600 tons per day is handled. The annual report for the year ended March 31 shows a deficit of $455,456 owing to the mill having been closed during the year. General-manager Kaeding anticipates that the scheme of underground development, which has been carried out, will result in great economy in operations, keeping costs down to about $2·50 per ton. The system of ore-passes has been so arranged that the entire tonnage above the 850 ft. level, about 2,000,000 tons, need be handled only once by manual labour. The mine now has a thoroughly modern and adequate plant, serving it to a depth of 1,150 ft., with which if necessary 3,000 tons of ore and waste can be extracted in two shifts of 8 hours each. There is six months' supply of ore now broken ready for the mill. The West Dome mine, adjacent to the Dome Mines, which was closed owing to the shortage of labour, will shortly be re-opened, the necessary funds having been secured. The Clifton Porcupine, a newly-formed company, has taken over the Preston claim, south of the Dome. A complete mining plant is being installed. At the Sovereign, development has been resumed, funds being raised by the sale of 300,000 shares of treasury stock. Diamond-drilling is being done to test promising surface showings at depth. At the Armstrong-Booth, now known as the Anzac, adjacent to the Plenaurum, diamond-drill operations are under way.

KIRKLAND LAKE.—The Provincial Government had promised the construction of a branch railway from Swastika to the Kirkland Lake area, but the mining companies made strong representations favouring the building of a good motor road between these points in place of a railway. This request has been acceded to and it has been decided to construct a "tarvia" macadam road at a cost of $10,000 to $12,000 per mile. This will greatly reduce the cost and difficulty of transportation, which has been a serious handicap to the development of the district. During March the Lake Shore mill treated 1,855 tons of ore, producing $45,364, being an average of $24·46 per ton. Good progress is being made with development work at the Tough Oakes, where a force of 98 men are at work under the management of Col. H. H. Johnson. A new vein has been opened up at the 200 ft. level, with an average gold content of $20 per ton. The La Belle Kirkland is offering 500,000 shares of treasury stock for sale to finance further development. Diamond-drilling has been carried on to a depth of 700 ft., indicating a large tonnage of ore. The shaft of the Minaker-Kirkland has reached a depth of 100 ft. An agreement has been made by the directorate of the Canadian Kirkland to give an option on the property to the Crown Reserve of Cobalt, subject to the ratification of the shareholders. The Ontario-Kirkland has sunk to the 320 ft. level, and is running a cross-cut at 300 ft. to pick up the vein which left the shaft at 175 ft.

COBALT.—The ore-sampling plant recently owned by the firm of Campbell & Deyell has been taken over by the Ontario Government. The owners some time since announced their intention of closing down and disposing of the business, which would have been a serious blow to the mining industry. This has been averted by the action of the Department of Mines, and the plant will continue to operate under the supervision of Arthur A. Cole, mining engineer for the Temiskaming & Northern Ontario Railway. The production of the Mining Corporation of Canada for 1918 amounted to 1,708,252 oz. of silver, as compared with 4,485,541 in 1917, the net profits being $925,760, as against $2,557,091. Ore reserves at the close of the year were 1,240,550 oz. The Nipissing during 1918 produced 3,701,416 oz. of silver, being a decrease of 510,831 oz. as compared with 1917. The gross value of the output was $4,040,446, as compared with $3,756,889, and the profits $2,596,095, as against $2,698,902. The ore reserves were estimated at about 6,000,000 oz. The output of the McKinley-Darragh for the first quarter of 1919 was approximately 275,000 oz., being a considerable increase over last year's rate of production. The Crown Reserve has installed an electric haulage system, the first to be put in operation in the Cobalt district. It has resulted in a marked increase in efficiency. An important find has been made at the Beaver, where a 4 in. vein stated to carry over 2,000 oz. to the ton has been discovered at the 600 ft. level. At the Adanac considerable quantities of high-grade ore are being extracted. A vein 6 to 10 in. wide, carrying high-grade ore in places, is being opened up in a winze sunk from the 300 ft. level. A 2 in. high-grade vein has been cut on the 600 ft. level of the Ophir.

OIL EXPLORATION IN ALBERTA.—The Imperial Oil Co. has laid out a campaign for exploration and development in Northern Alberta involving an expenditure of $500,000. Eight geological research parties have been sent out to investigate hitherto unexplored areas. Two oil-drilling equipments are on their way, one of which will be set up at Great Slave Lake, and the other at a point on the Mackenzie River, fully 1,000 miles farther north than any place at which drilling for oil has so far been carried on. Three other drills will go to the Peace



New Dredge for the British Platinum and Gold Corporation.

River district and other parts of Northern Alberta. There are several other companies operating or preparing to operate in the Peace River district where there were at last accounts nine drills and many others on the way. The total amount to be spent in the search for oil in Alberta and adjacent points this season, including the large outlay of the Imperial Oil Co., is estimated at approximately $1,000,000.

A Dredge for Colombia.

We give herewith some particulars of a dredge that has been built for the British Platinum & Gold Corporation, of London, a company owning large properties in the Choco district of the Republic of Colombia, South America. As mentioned in the Magazine for August, 1918, the placers are extensive, averaging 36d. per yard, 75% being in platinum and 25% in gold. The dredge was designed by Inder, Henderson, & Dixon, 1, London Wall Buildings, London, E.C.2, and built by Lobnitz & Co., Ltd., Renfrew, Scotland. The photograph shows the dredge as completed in the works at Renfrew, before it was dismantled for shipment to Buenaventura. The pontoons are 106 ft. long, 38 ft. wide, and 8 ft. deep; the buckets are of 8 cubic feet capacity, and the dredging depth is 30 ft. below water-level. In place of the usual revolving screen and elevator, two propulsion screens are provided, which will deposit the tailing some 16 ft. above water-level well behind the pontoons; in this particular instance a great saving is effected in first cost, freight and transport, and up-keep. The boiler is of the water-tube type and made by Babcock & Wilcox, Ltd., and is arranged to burn oil-fuel or wood, or both combined. Two centrifugal pumps are supplied, capable of delivering 5,000 gallons and 1,250 gallons of water per minute respectively. The main engines are of the condensing type and are capable of developing 350 h.p. The manœuvring of the dredge will be carried out by one large winch having six barrels, and a special winch for the ladder line, so arranged as to be under the control of one man. The dredge is lit throughout by electric light supplied by a steam generator of the high-speed type.

PERSONAL.

LAWRENCE ADDICKS is here from New York.

A. H. AITKEN has been demobilized and is returning to New Zealand.

A. W. ALLEN has resigned from the editorial staff of the *Engineering and Mining Journal*, and is going to Chile.

H. FOSTER BAIN has resigned as assistant director of the United States Bureau of Mines and is on his way to China.

HOWLAND BANCROFT and B. L. THANE have entered into partnership as consulting engineers, with offices in the Crocker Building, San Francisco.

CAPTAIN C. A. BANKS, R.E., has been demobilized and is at present in London.

E. G. BANKS, general manager of the Waihi gold mine, has arrived in England, having travelled by way of the United States.

E. J. CARLYLE has joined the staff of the British American Nickel Corporation and is at the Murray mine.

MAJOR THOMAS S. CHALMERS, U.S. Engineers, has returned from France to Chicago Heights, and has resumed business as president of Chalmers & Williams

A. E. DRUCKER has severed his connection with Howard, Morinni, & Co., and has opened an office at 30, Church Street, New York, where he will specialize on the recovery of metals from foundry residues.

JOHN WELLINGTON FINCH has returned to China from the United States.

B. L. GARD'NER has been demobilized, and has been appointed assistant secretary to the Institution of Mining and Metallurgy.

SIR RICHARD A. GREGORY has been elected president of the Old Students' Association of the Royal College of Science, South Kensington.

H. C. HOOVER has received the degree of LL.D. from Manchester University.

THEODORE J. HOOVER has been appointed Dean of the Mining Department of Stanford University and will take office on October 1.

T. J. JONES is on his way to Kyshtim, leaving San Francisco on May 29.

DR. WALTER P. JOSHUA is leaving for the Messina mine, Northern Transvaal.

G. F. LAYCOCK is going to Atbasar, Siberia, by way of the United States and Japan.

SIR OLIVER LODGE has been presented with the Albert Medal of the Royal Society of Arts in recognition of his work as the pioneer of wireless telegraphy. It is noteworthy that Sir Oliver was also the pioneer of electrostatic precipitation of dust from gases.

FRANK LUSH leaves for Nigeria on the 25th inst.

E. D. McDERMOTT has been demobilized, and has been appointed manager of the Cape Copper Company's works in India.

F. W. McNAIR, president of the Michigan College of Mines, has been appointed consulting engineer to the United States Bureau of Standards.

JAMES MILLER is returning to Brazil.

WILLET G. MILLER is here from Canada.

D. P. MITCHELL has returned from the United States.

T. M. OWEN is returning to Australia from Idaho for a short time in order to study the latest developments in flotation.

J. REED has left for the Frontino & Bolivia mines, Colombia.

JOHN ROWE has resigned as mechanical engineer at the Dolcoath mine, in order to take a similar position at the Geevor mine.

R. O. STOKES has joined the staff of the Dorr Company, in London.

LT.-COL. R. S. G. STOKES is commanding all Engineer troops, Allied Forces, Archangel.

D'ARCY WEATHERBE has returned from China by way of Canada and New York.

GEORGE F. BECKER, a distinguished American geologist, died at Washington on April 21, aged 72. He was a graduate of Harvard, and subsequently studied at Heidelberg and Berlin. He was for a few years instructor in mining in the University of California, and then joined the United States Geological Survey, with which he was connected for forty years. His reports on the South African gold deposits and diamond fields will be remembered. He also made a study of the Philippine Islands.

TRADE PARAGRAPHS

THE KEIGHLEY GAS & OIL ENGINE CO., LTD., of Keighley, Yorkshire, send us particulars of their gas and oil engines.

RUSTON & HORNSBY, LTD., of Lincoln, send us a pamphlet with coloured illustrations commemorating the construction of the firm's 1,000th aeroplane.

It is announced that VICKERS, LIMITED, have made an offer to purchase the control of W. T. GLOVER & CO., LTD., makers of electric wires and cables.

THE BRITISH WESTINGHOUSE ELECTRIC & MANUFACTURING CO., LTD., of Manchester, send us an elaborate portfolio of photographs of electric winding plants erected by them in various parts of the world.

THE OERLIKON COMPANY, of Switzerland, send us pamphlets relating to their electrical machinery. They have an agency at Oswaldestre House, Norfolk Street, London, W.C.2.

THE STAR DRILLING MACHINE CO., of Akron, Ohio, send an elaborate catalogue describing their portable drilling outfit, used for drilling for water and oil and for prospecting for coal and ore deposits.

THE CAMBRIDGE SCIENTIFIC INSTRUMENT CO. LTD., of Cambridge, send us their pamphlets relating to their glass thermometers intended for a variety of industrial uses, and their electrical distance recording thermometers of the resistance type.

THE CHICAGO PNEUMATIC TOOL CO., of Chicago, have appointed Allen E. Goodhue as managing director of their English subsidiary, the Consolidated Pneumatic Tool Co., Ltd., of 170, Piccadilly, London, and Fraserburgh, Scotland.

THE YOUROVETA HOME & FOREIGN TRADE CO., of 165, Broadway, New York, is a recently-formed company representing a Russian company of the same name. The company has acquired a controlling interest in the International Engineering & Trading Co., of Petrograd, which was well known before the war as an importer of machinery of all kinds into Russia and Siberia.

THE HARDINGE CONICAL MILL CO., of Denver, Colorado, reports the honourable discharge from war service of J. C. Farrant, its London Manager. Mr. Farrant for over four years was held a prisoner of war in Germany. [We are publishing his diary in current issues.—EDITOR.] 1st Lieut. J. J. Cadot, of Air Service, A.E.F., returns to take charge of its Denver office. Capt. Harlowe Hardinge, Signal Corps, Director Radio Schools in the A.E.F., will return to his duties as Vice-President of the company in the New York office. The Hardinge Company anticipates the early return of three more of its staff and a consequent renewal of its highly efficient service to its customers.

DAILY LONDON METAL PRICES: OFFICIAL CLOSING PRICES ON
Copper, Lead, Zinc and Tin per Long Tons; Silver

	Silver	Copper: Standard Cash	Copper: Standard (3 mos.)	Copper: Electrolytic	Copper: Best Selected	Lead: Soft Foreign
May	d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
12	58	76 5 0 to 76 10 0	76 15 0 to 77 0 0	80 0 0 to 80 10 0	80 10 0 to 81 0 0	24 0 0 to 24 5 0
13	55½	76 15 0 to 77 0 0	77 5 0 to 77 10 0	80 10 0 to 81 10 0	80 10 0 to 81 10 0	24 5 0 to 24 10 0
14	54	77 5 0 to 77 10 0	77 15 0 to 78 0 0	81 0 0 to [illegible] 0 0	80 10 0 to 81 10 0	24 5 0 to 24 10 0
15	53⅝	77 10 0 to 77 15 0	77 15 0 to 78 0 0	81 0 0 to 82 0 0	80 10 0 to 81 10 0	24 7 6 to 24 12 6
16	54	78 0 0 to 78 5 0	78 5 0 to 78 10 0	81 10 0 to 82 10 0	81 10 0 to 82 10 0	24 7 6 to 24 12 6
19	53½	79 0 0 to 79 5 0	79 5 0 to 79 10 0	82 0 0 to 83 0 0	81 10 0 to 82 10 0	24 7 6 to 24 12 6
20	52[illegible]	79 5 0 to 79 10 0	79 0 0 to 79 [illegible]	82 [illegible] to 83 0 0	82 0 0 to 83 0 0	24 7 6 to 24 10 0
21	51	79 7 6 to 79 12 6	79 [illegible] 6 to 79 12 6	82 0 0 to 83 0 0	82 0 0 to 83 0 0	23 10 0 to 23 15 0
22	[illegible]	79 15 0 to 80 0 0	79 15 0 to 80 0 0	82 10 0 to 83 10 0	82 0 0 to 83 0 0	23 10 0 to 23 15 0
23	51¾	78 10 0 to 78 15 0	78 15 0 to 78 17 6	82 10 0 to 83 10 0	82 10 0 to 83 10 0	23 10 0 to 23 15 0
26	[illegible]	78 15 0 to 78 17 6	78 17 6 to 79 0 0	82 0 0 to 83 0 0	82 10 0 to 83 10 0	23 5 0 to 23 10 0
27	[illegible]	79 2 6 to 79 7 6	79 5 0 to 79 10 0	82 0 0 to 83 0 0	82 0 0 to 83 0 0	23 0 0 to 23 5 0
28	[illegible]	79 2 6 to 79 7 6	79 5 0 to 79 7 6	82 0 0 to 83 0 0	82 0 0 to 83 0 0	22 15 0 to 23 0 0
29	[illegible]	79 0 0 to 79 5 0	79 0 0 to 79 5 0	82 0 0 to 83 0 0	82 0 0 to 83 0 0	22 15 0 to 23 0 0
30	52½	78 15 0 to 79 0 0	79 0 0 to 79 5 0	82 0 0 to 83 0 0	82 0 0 to 83 0 0	22 15 0 to 23 0 0
June						
2	[illegible]	79 10 0 to 79 15 0	79 15 0 to 80 0 0	82 0 0 to 83 0 0	82 0 0 to 83 0 0	22 15 0 to 23 0 0
3	53⅜	79 5 0 to 79 10 0	79 5 0 to 79 10 0	81 10 0 to 82 10 0	81 10 0 to 82 10 0	22 15 0 to 23 0 0
4	53½	78 10 0 to 78 15 0	78 15 [illegible] to 79 0 0	81 10 0 to 82 10 0	81 10 0 to 82 10 0	22 15 0 to 23 0 0
5	[illegible]	78 15 0 to 79 0 0	79 0 0 to 79 5 0	81 10 0 to 82 10 0	81 10 0 to 82 10 0	22 15 0 to 23 0 0
6	[illegible]	79 7 6 to 79 12 6	79 15 0 to 80 0 0	82 0 0 to 83 0 0	82 0 0 to 83 0 0	22 5 0 to 22 0 0
10	53⅝	80 10 0 to 80 15 0	80 15 0 to 81 0 0	[illegible] 0 0 to 84 0 0	83 0 0 to 84 0 0	22 5 0 to 22 10 0

METAL MARKETS

COPPER.—Early in May the official figures of the stocks of copper held by the Government on May 1 were published. Exclusive of old metal and scrap, these were 51,130 tons. This showed an increase of 2,428 tons on the figures of a month previously. Although these were considered disappointing in so far as the stocks continue to increase, the announcement of the figures had no material effect one way or another upon the market. Values during the period under review have become considerably firmer, this remark applying especially to standard copper, although refined has also improved. An increasing interest has been taken in the standard market, most of the buying being confined to forward positions. It has been generally rumoured here, and the report certainly seems very probable, that some of the strength in the standard market has been due to American buying, with the object, of course, of selling electrolytic. Certain it is, however, that an upward movement has been in evidence in America during the past month, and considerable quantities of the metal are understood to have changed hands, while prices gradually advanced. It seems, however, that a certain amount of the copper which has been sold there must have found its way into the hands of dealers, as there have been repeated offers of refined copper on this side at prices below those asked by the chief producers. So far as appearances go, it certainly looks as if an attempt had been made to get a move on the market by putting prices up with the aid of the more optimistic tone in Wall Street. The statistical position, however, does not appear any too satisfactory. Several properties in America have stopped producing altogether, and others have curtailed operations to the extent of something like 50% ; but in spite of that very large cut-down in output, there was insufficient demand to absorb the metal produced, and stocks appear to have been accumulating.

Copper ores are quiet ; 15-25% are quoted at 12s. to 12s. 6d. nominal per unit.

Average prices of cash standard copper: May 1919, £77. 16s. 8d. ; April 1919, £77. 7s. ; May 1918, £110. 5s. ; April 1918, £110. 5s.

TIN.—The market has seen considerable fluctuations again during the month. Values at the commencement stood at about £226. 15s. cash and £226. 5s. three months, this level gradually improving, until on the 19th cash stood at £246. 15s. and three months at £242. 15s. Thereafter values steadily eased off until at the close cash was quoted at £232. 7s. 6d. and three months at £228. 17s. 6d. A very considerable business has been done in the standard market, where covering by short interests as well as some export demand were instrumental in raising prices in the middle of the month as mentioned. This brought the parity of the standard market above the price which it was understood was held for in the Straits Settlements, and there was some conjecture here as to whether this would cause holders in the East to raise their selling prices. As it turned out, reports came to hand which appeared to indicate that holders in the East were prepared to make concessions : but as it happened these advices showed that business had been done in the East on the basis of delayed cablegrams from London, so that when they accepted a lower price they were unaware of the high levels to which the market in London had attained. Subsequently values in the East rallied on news of the better tone here, only to come down again later on in sympathy. The fact that cables take some time in transmission makes it impossible to compare the parity of the two markets at the same time. A great deal of interest has been felt in the position in the United States, and it was hoped that at an early date the embargo on imports would be removed. It is now reported that the ban on the imports of tin ore and concentrates will be raised on July 1, and the expectations in America are apparently that tin would soon be free from control altogether. This opinion was received with satisfaction here, as it was feared that the fact that the embargo had been raised on the raw material might mean that imports would still be forbidden so far as actual tin itself was concerned. Meanwhile considerable purchases are understood to have been made, both in the Straits Settlements and in this country, for shipment to America when the restrictions are removed. Stocks, however, appear to be considerably larger in America than has been generally supposed.

The average price of cash standard tin : May 1919, £234. 9s. 5d. ; April 1919, £225. 6s. 6d. ; May 1918, £364. 7s. 8d. ; April 1918, £329. 18s. 1d.

LEAD.—This market closed the month at a rather lower level than at the end of April. The tone for the greater portion of May was very steady, but latterly

THE LONDON METAL EXCHANGE.
per Standard Ounce.

Zinc (Spelter)	Standard Tin: Cash	Standard Tin: 3 mos
£ s. d. £ s. d.	£ s. d. £ s. d.	£ s. d. £ s. d.
34 15 0 to 35 5 0	236 0 0 to 236 10 0	233 0 0 to 233 10 0
35 5 0 to 35 15 0	235 0 0 to 235 10 0	232 15 0 to 233 0 0
35 5 0 to 35 10 0	236 0 0 to 236 10 0	233 10 0 to 233 15 0
35 5 0 to 35 15 0	237 0 0 to 237 5 0	234 0 0 to 234 5 0
35 15 0 to 36 5 0	241 15 0 to 242 0 0	237 5 0 to 237 15 0
36 0 0 to 36 10 0	246 10 0 to 247 0 0	242 10 0 to 243 0 0
36 0 0 to 36 10 0	245 5 0 to 245 10 0	241 5 0 to 241 10 0
36 0 0 to 36 10 0	238 15 0 to 239 0 0	236 15 0 to 237 0 0
36 5 0 to 36 15 0	236 0 0 to 236 10 0	232 5 0 to 232 10 0
36 5 0 to 36 10 0	233 0 0 to 233 10 0	228 15 0 to 229 0 0
36 5 0 to 36 10 0	235 10 0 to 236 0 0	230 15 0 to 231 0 0
35 15 0 to 36 5 0	236 10 0 to 237 0 0	230 10 0 to 231 0 0
36 0 0 to 36 5 0	235 0 0 to 235 10 0	230 0 0 to 230 10 0
36 0 0 to 36 5 0	233 0 0 to 233 10 0	229 5 0 to 229 10 0
35 15 0 to 36 0 0	232 5 0 to 232 10 0	228 15 0 to 229 0 0
35 10 0 to 35 15 0	235 0 0 to 235 10 0	231 0 0 to 231 10 0
35 10 0 to 35 15 0	235 0 0 to 235 10 0	231 0 0 to 231 10 0
35 10 0 to 35 15 0	233 15 0 to 234 5 0	230 15 0 to 231 0 0
35 10 0 to 35 15 0	233 0 0 to 233 10 0	229 10 0 to 230 0 0
35 10 0 to 35 15 0	233 15 0 to 234 5 0	229 10 0 to 230 0 0
36 0 0 to 36 10 0	235 5 0 to 235 10 0	230 15 0 to 231 0 0

the announcement that the Government has reduced its selling price by 20s. to £24 had the natural effect of depressing quotations in the open market. Up till then a fairly good demand had been seen from the consuming trades, and there seemed to be generally signs of returning confidence. Since the authorities reduced their selling price, however, buyers have been rather afraid to enter the market in case further reductions should take place. Consequently business has been quiet latterly, consumers confining their purchases to immediate requirements only. It has been reported that Germany has been offering lead in neutral countries at under £25. It is difficult to understand that they can have any great quantity for disposal, but no doubt this may have been preventing this country from getting as much of the business from neutrals as they might otherwise have done. This may explain the Government's action in reducing their selling price As it is, export business has been rather quiet. The statistical position of this metal is far from satisfactory. There appears to be a considerable stock in America as well as in Australia, while the Government stocks in this country on May 1 amounted to 109,012 tons, which showed an increase of no less than 12,556 tons since the beginning of April.

The average prices of soft pig lead: May 1919, £23. 18s. 6d. net; April 1919, £24. 8s. 7d.; May 1918, £29; April 1918, £29.

SPELTER.—The market has shown an improving tendency during the past month, although the rise which has taken place in prices is, on balance, of no importance. Generally speaking the market has had a considerably better aspect, and more interest has been taken by consumers who have been extending their interest to forward deliveries, whereas hitherto they had largely confined their purchases to immediate delivery metal. The Government is understood to have been able to dispose of fair quantities of metal, and in some quarters it was expected that the selling price would be advanced above £38, which is the present ruling figure. The Government stocks of G.O.B. spelter on May 1 amounted to 26,912 tons, thereby showing a decrease of 764 tons when compared with the previous month. Refined spelter stocks meanwhile had decreased by 3,314 tons to 7,057 tons on May 1. The American market has shown a steadily advancing tendency during the period under review. Values of spot metal at the beginning of the month stood at about 6 cents, that position being worth about 6·20c. at the end of May. Early in the month an announcement was made by the directors of the National Smelting Co., which was putting up large works at Avonmouth, regretting that it was necessary to give notice to the workmen to finish contracts on May 3. Since the buildings were started the increase in the cost of materials and wages by over 100% had rendered that step necessary. These increases made it impossible to construct an economic plant capable of meeting foreign competition. It is intended, however, to resume work if the position becomes more favourable.

The average prices for spelter: May 1919, £35. 13s. 9d.; April 1919, £35. 18s. 3d.; May 1918, £52; April 1918, £52.

ZINC DUST.—High-grade Australian zinc dust 88–92% purity is quoted at £70 per ton f.o.r. Liverpool.

ANTIMONY.—The price of English regulus is unchanged at £45 per ton, without much doing. Foreign material has been firmer, as the stocks in warehouse are getting gradually diminished. Up to £43 has been realized and the market about £40 to £43.

ARSENIC.—The market remains quiet, there being very little moving. The present price is about £35 per ton delivered London for white.

BISMUTH.—Nominal at 12s. 6d. per lb.

CADMIUM is steady at 6s. 9d. to 7s. per lb.

ALUMINIUM.—£150 per ton for the home trade.

NICKEL.—£195 per ton for the home trade.

COBALT METAL.—12s. 6d. to 13s. per lb

COBALT OXIDE.—7s. 9d. per lb.

PLATINUM.—442s. per oz.

PALLADIUM.—Nominal 500s. per oz.

QUICKSILVER.—The market has been firm and the quotation is now about £18 to £18s. 10s. per flask.

SELENIUM.—12s. to 15s. per lb.

TELLURIUM.—95s. to 100s. per lb.

SULPHATE OF COPPER is quoted for export at £48 f.o.b. The price for the home trade is £45.

MANGANESE ORE.—There is not much being done in this, and the tendency is easy. · Prices are about 2s. 1d. to 2s. 2d. per unit c.i.f.

TUNGSTEN ORE.—Wolframite 65%, 30s. per unit, and scheelite 40s. per unit.

MOLYBDENITE.—85%, 105s. per unit.

SILVER.—The market here as well as in America has fluctuated somewhat during the past month in an upward direction, and at the end of May the price of spot standard in London was 53d. while the value of spot fine in New York was 109½c

CORUNDUM.—Values are nominal.

GRAPHITE.—80%, £45 per ton c.i.f. U.K.

IRON AND STEEL.—Since the control of these markets ceased at the end of April, business in pig iron has been very brisk, and in spite of the fact that prices were increased at the beginning of the month, these have become still further enhanced during the past few weeks. The result is, for example, that Cleveland No.3, for which the minimum price was fixed at 140s., has advanced to 160s. for delivery during May and June. Since then it is understood that makers have agreed to regard 160s. as a maximum price, and this intimation was received with general satisfaction by the trade. With regard to steel, manufacturers seem to have plenty of work on hand, but appear to be careful to confine their bookings as much as possible to near-by deliveries owing to the obscurity with regard to future costs, not to mention the general complexities of the labour situation. Meanwhile America has made sales to this country, a recent report mentioning business done in billets at £13. 10s. c.i.f.

STATISTICS.

[illegible] of Gold in the Transvaal

	Rand	[illegible] where	Total	Value
	Oz.	Oz.	Oz.	£
[illegible] 1918	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
June	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	16 010	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
October	667,955	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
January, 1919	662,205	13,854	676,059	[illegible]
[illegible]	[illegible]	15,540	636,728	[illegible]
March	694,825	17,554	712,379	[illegible]
[illegible]	[illegible]	18 242	[illegible]	[illegible]

Natives Employed in the Transvaal Mines

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1918	176,424	11,469	4,715	192,608
February 28	181,066	11,243	4,825	197,134
March [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
April [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
May 31	179,879	11,211	4,773	195,863
June [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
July 31	178,412	11,790	5,011	195,213
August 31	179,390	11,950	4,954	196,294
September [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
October 31	173.153	11.824	4,749	189,726
November [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
December [illegible]	[illegible]	11,551	3,180	[illegible]
January 31, 1919	160,599	11,848	3,539	175,986
February 28	172,359	11,868	[illegible]	188,491
March 31	175,620	11,168	5,080	191,868
April 30	175,267	[illegible]	5,742	192,915

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 60% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s d	s. d	s. d.	£
January, 1918	2,167,411	27 1	20 7	6 4	703,665
February	1,946,338	27 [illegible]	21 7	5 11	577,396
March	2,107,561	27 1	21 4	5 [illegible]	596,109
April	2,181,609	27 0	20 8	6 2	670,871
May	2,237,644	27 3	20 6	6 5	716,963
June	2,124,205	28 2	21 0	6 11	736,694
July	2,167,869	[illegible] 10	21 [illegible]	6 6	702,360
August	2,158,431	[illegible] 1	21 7	6 [illegible]	676,146
September	2,060,635	[illegible] 2	22 0	5 10	600,330
October	2,015,144	[illegible] 0	22 5	5 3	531,774
November	1,899,925	[illegible] 5	23 1	5 1	480,102
December	[illegible]	[illegible] 7	[illegible] 0	5 6	507,860
Year 1918	24,922,763	[illegible] 11	[illegible] 7	6 0	[illegible]
January, 1919	1,942 329	[illegible] 9	23 0	5 [illegible]	547,7[illegible]
February	1,816,352	[illegible] 9	23 [illegible]	5 [illegible]	[illegible]

[illegible]oduction of Gold in Rhodesia and West Africa.

	Rhodesia. 1918	Rhodesia. 1919	West Africa. 1918	West Africa. 1919
	£	£	£	£
January	253,807	211,917	107,863	104,063
February	[illegible]	220,885	112,865	112,616
March	230,023	[illegible]	[illegible]	[illegible]
April	239,916	[illegible]	[illegible]	[illegible]
May	239,205	—	126,290	—
June	225,447		[illegible]	
July	251,740		[illegible]	
August	257,096		[illegible]	
September	247,885		[illegible]	
October	136,780		[illegible]	
November	145,460		[illegible]	
December	192,870		[illegible]	
Total	2,652,250	871,770	1,333,553	438,792

[illegible]vaal Gold Outputs.

	April, 1919 Treated	Value
	Tons	£
[illegible]	13.800	13,640
[illegible]		
[illegible]	—	674
[illegible]	47,500	88,908
City & Suburban	17,342	28,374
City Deep	48,500	97,209
[illegible]	45.000	55 516
Cons. Main Reef	47,300	[illegible]
Crown Mines	158,000	217,122
[illegible]	25,200	35,025
[illegible]	110,000	138,201
[illegible]	32,300	56,264
[illegible]	42.000	61,920
[illegible]	47,500	54,081
[illegible]	10,520	10,081
[illegible]	3,970	7,217
[illegible]	16 600	11,926
Government G.M. Areas	116.000	204,450
[illegible]	10,610	14,678
[illegible]	21,200	23,636
[illegible]	57,900	71,179
[illegible]	20,000	29,963
Knights Deep	82,900	70,507
[illegible]	[illegible]	52,331
[illegible]	20 000	—
[illegible]	13,640	39,396
[illegible]	82,000	173,162
[illegible] B	54,000	121,206
[illegible] Deep	41,100	88,943
[illegible]	12,000	11,855
[illegible]	38,100	53,824
[illegible]	19,000	17,159
Princess Estate	19,400	25,382
Randfontein Central	138,000	162,705
[illegible]	36,300	41,812
Robinson Deep	45,300	61,750
[illegible] United	24,200	22,835
Rose Deep	53,000	62,860
Simmer & Jack	46,800	45,652
Simmer Deep	38,600	38,789
[illegible]	34,940	67,297
[illegible] Nigel	9,519	24,158
Transvaal G.M. Estates	14,980	23,812
Van Ryn	35,150	33,374
Van Ryn Deep	47,400	103,559
Village Deep	43,400	62,547
Village Main Reef	17,700	22,935
West Rand Consolidated	32,000	37,718
Witwatersrand (Knights)	32,500	40 733
Witwatersrand Deep		—
Wolhuter	28,500	35,385

West African Gold Outputs.

	April, 1919 Treated	Value
	Tons	£
Abbontiakoon	8,002	16,217
Abosso	7,100	12,255
Ashanti Goldfields	8,139	8,862
Prestea Block A	14,930	24,803
[illegible]ah	5,100	14,234
[illegible]	—	4,108

Rhodesian Gold Outputs.

	April, 1919 Treated	Value
	Tons	£
Antelope	3,200	4,722
Cam & Motor	—	—
Eldorado Banket	4,021	10 235
[illegible]	14,522	28,036*
Gaika	3,066	5,310
Globe & Phœnix	5,754	7,976†
[illegible]	4,640	[illegible]
Rezende	5,300	13 [illegible]‡
Rhodesia, Ltd.	545	1,271
Shamva	56,595	33,916
Transvaal & Rhodesian	1,800	5,400
Wanderer	10,070	[illegible]

* Gold, Silver, and Copper; † Ounces Gold; ‡ Gold & Silver

West Australian Gold Statistics

	Reported for Export oz	Delivered to Mint oz	Total oz	Total value £
January, 1918	*	73,703	*	*
February		76,987	*	*
March		6[illegible] 73[illegible]	*	*
April		66 079		*
May	*	73,701		*
June	*	74,904	*	*
July		72,081	*	*
August	*	76,156	*	*
September		74,057		*
October	*	71,439	*	*
November	1,444	70,711	72,155	306,494
December	2,7[illegible]9	61,314	64,053	272,[illegible]08
January, 1919		69,954	*	
February	7[illegible]	66,310	67,043	284,779
March	*nil*	66,158	66,158	281,120
April		63,465	63,498	26[illegible],720

* By direction of the Federal Government the export figures from July 1916 to November 1918 were not published.

Australian Gold Returns.

	Victoria		Queensland		New South Wales	
	1918	1919	1918	1919	1918	1919
	£	£	£	£	£	£
January	32,134	36,238	47,600	37,100	25,000	18,000
February	58,113	46,955	45,470	43,330	28,000	24,000
March	55,412	40,267	48,020	48,000	30,000	16,000
April	26,849	—	47,600	61,200	30,000	24,000
May	87,825		46,740	—	45,000	—
June	45,765		51,420		32,000	—
July	64,347		51,000		25,000	—
August	61,163	—	44,600	—	21,000	—
September	65,751	—	45,900	—	32,000	—
October	*		54,400		40,000	—
November	*	—	38,200	—	25,000	—
December	70,674	—	56,281	—	38,000	—
Total	674,655	123,461	578,213	189,630	370,000	82,000

* Figures not received.

Australasian Gold Outputs.

	April, 1919 Treated Tons	Value £
Associated	5,564	8,137
Associated Northern Blocks — Iron Duke	—	2,450*
Associated Northern Blocks — Victorious	1,736	3,786
Blackwater	2,034	3 563
Bullfinch	4,673	5,132
Golden Horseshoe	11,820	22,983
Great Boulder Prop	11,988	35,090
Ivanhoe	16,485	30,080
Kalgurli	3,6[illegible]0	6,483
Lake View & Star	10,062	11,709
Mount Boppy	—	—
Oroya Links	1,465	9,253†
Progress	1,450	1,705
Sons of Gwalia	12,842	16,774
South Kalgurli	7,733	10,079
Talisman	—	—
Waihi	13,968	22,664‡
Waihi Grand Junction	4,900	7,372§

* Surplus; † Total receipts; ‡ Gold and Silver to April 19
§ 22 days to April 19.

Miscellaneous Gold Output

	April, 1919 Treated Tons	Value £
Barramia (Sudan)	—	721
Esperanza (Mexico)	12,443	3,748††
Frontino & Bolivia (Colombia)	2,330	8,332
Nechi (Colombia)	28,767*	28,950‡
Ouro Preto (Brazil)	6,800	9,600
Pato (Colombia)	49,031*	10,540‡
Philippine Dredges (Philippine Islands)	—	[illegible]468§
Plymouth Cons. (California)	10,700	12,496
St. John del Rey (Brazil)	—	37,000
Santa Gertrudis (Mexico)	33,760	24,5[illegible]0††
Sudan Gold Field (Sudan)	1,350	3,173

* Cubic yards; ‡ Dollars; § Ounces, fineness not stated.
†† Profit, gold and silver

Production of Gold in India

	1916	1917	1918	1919
	£	£	£	£
January	192,150	190,047	176,030	162,270
February	183,264	180,904	173,343	153,775
March	186,475	1[illegible],618	177,950	162,790
April	192,[illegible]08	185,835	176,486	162,550
May	193,604	184,874	173,775	
June	192,469	182,426	17[illegible],[illegible]75	
July	191,404	179,660	171,950	
August	192,784	181,005	172,105	
September	192,330	183,630	170,360	
October	191,502	182,924	167,740	
November	192,298	182,388	157,176	—
December	205,164	190,852	170,630	—
Total	2,305,652	2,214,163	2,061,920	643,385

Indian Gold Outputs.

	April, 1919 Tons Treated	Fine Ounces
Balaghat	2,400	2,137
Champion Reef	11,329	6,[illegible]5
Hutti (Nizam's)	—	9[illegible]0
Jibutil		—
Mysore	24,350	13,521
North Anantapur	1,200	[illegible]20
Nundydroog	[illegible],7[illegible]	6,454
Ooregum	12,800	7,3[illegible]1

Base Metal Outputs.

		April, 1919
Arizona Copper	Short tons copper	1,200
British Broken Hill	Tons lead concentrate	2,057
	Tons zinc concentrate	1,600
	Tons carbonate ore	385
Broken Hill Block 10	Tons lead concentrate	1,533
	Tons zinc concentrate	1,642
Burma Corp.	Tons refined lead	1,710
	Oz. refined silver	209,000
Cordoba Copper		—
Freemantle Trading	Long tons lead	—
North Broken Hill	Tons lead	1,493
	Oz silver	60,984
Poderosa	Tons copper ore	270
Rhodesian Broken Hill	Tons lead and zinc	1,202
Tanganyika	Long tons copper	1,965
Tolima	Tons silver-lead concentrate	30
Zinc Corp.	Tons zinc concentrate	6,515
	Tons lead concentrate	3,495

Imports of Ores and Metals into United Kingdom
Long tons.

	May 1919 Tons	Year 1919 Tons
Iron Ore	430,232	2,232,201
Copper Ore	1,293	8,343
,, Precipitate	584	5,755
,, Metal	10,129	63,859
Copper and Iron Pyrite	33,626	121,941
Tin Concentrate	2,489	17,922
,, Metal	2,151	7,118
Manganese Ore	47,467	179,[illegible]
Lead, Pig and Sheet	27,840	129,[illegible]
Zinc (spelter)	10,715	49,[illegible]
Zinc Oxide	26	[illegible]
Barytes	2,920	6,550
Rock Phosphate	21,673	199,548
Brimstone	—	5,103
Boracic Compounds	1,[illegible]0	4,986
Nitrate of Potash	1,[illegible]13	[illegible]
	lb	lb.
Quicksilver	19,551	938,100

United States Metal Exports and Imports

Exports.	Jan. Tons.	Feb. Tons.	Imports	Jan Tons	Feb Tons.
Copper Ingots	32,480	13,595	Antimony	1 164	511
Copper Sheets	1,398	1 702	Tin Ore	2,741	1,451
Copper Wire.	1,468	2 640	Tin	3,777	2,8[illegible]0
Lead, Pig	7,8281	6.167	Manganese Ore	47,504	21,819
Zinc	6,[illegible]87	9,657	Tungsten Concentrate	87[illegible]	1,5[illegible]5
Zinc Sheets	1,521	4,161	Pyrites	7,42[illegible]	1,053

Outputs of Tin Mining Companies

In Tons of Concentrate.

	Year 1918 Tons	April 1919 Tons	Year 1919 Tons
Nigeria			
Abu	33	2	8
Anglo Continental	207	14	79
Benue	146	8	35
Bernda	—	-	1
Bisichi	275	8	48
Bongwelli	17	5	19
Dua	60	4	30
Ex Lands	342	30	118
Filani	57	.	7
Forum River	274	12	61
Gold Coast Consolidated	30	3	11
Gurum River	99	11	45
Jantar	141	10	40
Jos	228	19	66
Kaduna	178	19	70
Kano	60	15	60
Kassa-Ropp	133		24
Keffi	118	7	26
Kuru	12	30	89
Kuskie	21		1
Kwall	108	7	-
Lower Bisichi	99	7	37
Lucky Chance	27	3	11
Minna	40	3	11
Mongu	476	50	210
Naraguta	478	30	131
Naraguta Extended	280	15	68
New Lafon	198	21	83
Nigerian Tin	87	5	25
Ninghi		10	10
N. N. Bauchi	435	32	117
Offin River	120		15
Rayfield	689	60	257
Ropp	836	55	330
Rukuba	132	–	17
South Bukeru	94	4	19
Sybu	40	3	9
Tin Areas	96	8	28
Tin Fields	108	15	6[illegible]
Toro	17	1	3
Federated Malay States			
Chenderiang	179		52
Gopeng	979	72	299
Idris Hydraulic	136	18	77
Ipoh	245	12	42
Kamunting	236		96
Kinta	478	6	143
Kledang	28		8
Lahat	349	3	112
Malayan Tin	730	59	232
Pahang	1,877	190	676
Rambutan	207	18	63
Sungei Besi	408	28	89
[illegible]	508	[illegible]	161
[illegible]	400	23	110
[illegible]	1,364	101	4[illegible]
Tronoh South	133		
Cornwall:			
[illegible]	140		-
Dolcoath	7[illegible]	52	[illegible]
East Pool	1,3[illegible]6	92	415
Geevor	3[illegible]		115
South Crofty	[illegible]	[illegible]	1[illegible]
Other Countries:			
Aramayo Francke (Bolivia)	1 [illegible]16	1[illegible]	[illegible]
Briseis (Tasmania)	[illegible]	[illegible]	86
Deebook (Siam)	5[illegible]	[illegible]	10
Mawchi (Burma)	65[illegible]	1[illegible]	[illegible]10
Porco (Bolivia)	[illegible]7	[illegible]	[illegible]
Renong (Siam)	61[illegible]	87	[illegible]
Rooiberg Minerals (Transvaal)	[illegible]	34	144
Siamese Tin (Siam)	9[illegible]	18	187
Tongkah Harbour (Siam)	1[illegible]	[illegible]	355
Zaaiplaats (Transvaal)	5[illegible]	[illegible]	215

Nigerian Tin Production.

In long tons of concentrate of unspecified content

Note These figures are taken from the monthly returns made by individual companies reporting in London, and probably represent 85 % of the actual outputs

	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons	1919 Tons
January	485	417	531	667	678	613
February	469	358	528	646	668	623
March	502	418	547	655	707	587
April	482	444	486	555	584	531
May	480	357	536	509	525	
June	460	373	510	473	492	
July	432	455	506	479	545	
August	228	438	498	551	571	
September	289	442	535	538	520	
October	272	511	584	578	491	
November	283	467	679	621	472	
December	326	533	654	655	518	
Total	4,708	5,213	6 594	6 927	6,771	2,354

Total Sales of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
July 1	170½	£34,0[illegible]5	£199 12 5
July 15	164	£34,595	£210 19 0
July 29	146¼	£33,816	£231 4 6
August 12	144	£33,116	£229 19 6
August 26	142	£31,211	£219 16 0
September 9	142⅝	£28,793	£202 1 2
September 24	145¾	£29,639	£203 7 2
October 7	136½	£27,037	£197 14 3
October 21	150	£29,672	£197 16 4
November 4	141¼	£27,636	£195 13 1
November 18	150	£27,592	£183 19 9
December 2	166¾	£25,170	£150 19 0
December 16	175½	£26 032	£148 6 7
December 30	152	£19,539	£128 11 1
Total and Average, 1918	4,094	£786,541	£192 0 0
January 13, 1919	160	£20,838	£130 11 0
January 27	135½	£17,000	£125 10 7
February 10	153	£17,441	£113 19 10
February 24	142	£15 015	£105 14 10
March 10	144½	£18 123	£125 8 5
March 24	148¾	£17 877	£120 7 8
April 7	134⅛	£15 258	£113 8 10
April 22	134¼	£15,0[illegible]3	£111 18 1
May 5	129	£14,919	£115 13 2
May 19	126½	£15,844	£125 5 0

Details of Redruth Tin Ticketings

	May 5 Tons Sold	May 5 Realized per ton £ s. d	May 19 Tons Sold	May 19 Realized per ton £ s d
E Pool & Agar, No. 1	10	112 0 0	10	120 15 0
,, No. 1a	10	112 10 0	10	122 0 0
,, No. 1b	10	112 0 0	10	122 15 0
,, No. 1c	10	112 5 0	10	123 17 6
Dolcoath, No. 1	8	120 15 0	9	133 5 0
No. 1a	8	119 15 0	9	134 15 0
No. [illegible]	7	120 10 0	9	1[illegible]6 [illegible] [illegible]
N[illegible]	2½	[illegible]0 15 0	3	[illegible] 10 0
[illegible]	14	108 5 0	—	
South Crofty, No. 1	9	118 5 6	10	131 [illegible]0 [illegible]
,, ,, No. 1a	11	119 2 6	11	133 5 0
Grenville Utd., No. 1	7	113 2 6	8	125 0 0
,, No. 1a	6	11[illegible] 2 6	7	125 10 0
,, No. 2	—		[illegible]	[illegible]45 [illegible] 0
Tincroft Mines, No. 1	6	121 7 6	6	134 5 0
,, No. 1a	6	122 5 0	6	135 7 6
Levant Mines	17	121 15 0		- -
Wheal Bellan		–	1½	130 10 0
Hingston Downs			5½	136 15 0
Trencrom Hill	1	99 0 0		
Total	129		12[illegible]½	

PRODUCTION OF TIN IN FEDERATED MALAY STATES

Estimated at 70% of Concentrate shipped to Smelters Long Tons. *Figures not published.

	1915	1916	1917	1918	1919
	Tons	Tons	Tons	Tons	Tons
January	4,395	4,316	3,558	3,149	3,765
February ...	3,780	3,372	2,755	3,191	2,673
March	3,653	3,696	3,286	2,608	2,819
April	3,619	3,177	3,251	3,308	2,855
May	3,823	3,729	3,413	3,332	3,404
June	4,045	3,435	3,489	2,950	—
July	3,544	3,517	3,253	3,373	
August	4,046	3,732	3,413	3,259	
September	3,932	3,636	3,154	3,166	
October	3,797	3,681	3,435	2,870	—
November	4,059	3,635	3,300	3,131	—
December	4,071	3,945	3,525	3,023	—
	46,767	43,871	39,833	37,370	15,516

STOCKS OF TIN

Reported by A. Strauss & Co. Long Tons

	April 30 1919	May 31 1919
	Tons	Tons
Straits and Australian Spot	1,4[illegible]	1,199
Ditto Landing and in Transit	[illegible]	707
Other Standard, Spot and Landing	[illegible]	[illegible]
Straits Afloat	1,6[illegible]2	2,044
Australian, Afloat	3[illegible]5	3[illegible]6
Banca, on Warrants	—	—
Ditto Afloat		10[illegible]
Billiton, Spot		
Billiton, Afloat		
Straits Spot in Holland and Hamburg	—	—
Ditto Afloat to Continent	110	75
Total Afloat for United States..		10
Stock in America	1[illegible]0	100
Total ...	5,113	5,27[illegible]

SHIPMENTS, IMPORTS, SUPPLY AND CONSUMPTION OF TIN

Reported by A. Strauss & Co Long tons

	April 1919	May 1919
	Tons	Tons
Shipments from:		
Straits to U.K.	1,117	1,639
Straits to America	—	10
Straits to Continent	110	55
Australia to U.K.	200	150
U.K. to America	—	—
Imports of Bolivian Tin into Europe..	2,6[illegible]1	1,63[illegible]
Supply:		
Straits	1,227	1,704
Australian	100	150
Billiton	—	—
Banca	299	—
Standard	494	254
Consumption:		
U.K. Deliveries.....................	2,079	1,937
Dutch	39	112
American ..	36	2[illegible]
Straits, Banca & Billiton, Continental Ports, etc.	1,717	1[illegible]
Stocks in hands of Malay Government	6,000 to 7,000	6,000 to 7,000
„ controlled by U.S. Government	1,000 to 1,500	
„ .. French and Italian Governments.	1,000	—
Banca and Billiton controlled by Dutch Government	3,000 to 4,000	3,000 to 4,000

PRICES OF CHEMICALS. June 7

		£	s.	d.
Alum	per ton	17	0	0
Alumina, Sulphate of	„	19	0	0
Ammonia, Anhydrous...............	per lb.		1	10
„ 0·880 solution	per ton	32	0	0
„ Carbonate	per lb.			6½
„ Chloride of, grey......	per ton	50	0	0
„ „ „ pure......	per cwt.	4	0	0
„ Nitrate of	per ton	58	0	0
„ Phosphate of............	„	110	0	0
„ Sulphate of	„	17	10	0
Antimony Sulphide	per lb.		1	3
Arsenic, White........................	per ton	33	0	0
Barium Sulphate	„	12	0	0
Bisulphide of Carbon	„	54	0	0
Bleaching Powder, 35% Cl.	„	15	0	0
Borax	„	39	0	0
Copper, Sulphate of	„	45	0	0
Cyanide of Sodium, 100%.........	per lb			10
Hydrofluoric Acid	„			7
Iodine..	„		14	0
Iron, Sulphate of......................	per ton	5	0	0
Lead, Acetate of, white	„	85	0	0
„ Nitrate of	„	59	0	0
„ Oxide of, Litharge	„	45	0	0
„ White	„	52	0	0
Lime, Acetate, brown............. .	„	12	0	0
„ „ grey 80%............	„	17	0	0
Magnesite, Calcined	„	25	0	0
Magnesium Chloride	„	16	0	0
„ Sulphate...............	„	11	0	0
Methylated Spirit 64° Industrial	per gal.		6	7
Phosphoric Acid	per lb		1	8
Potassium Bichromate	„		2	0
„ Carbonate	per ton	85	0	0
„ Chlorate	per lb.		1	2
„ Chloride 80%	per ton	30	0	0
„ Hydrate,(Caustic) 90%	„	150	0	0
„ Nitrate.....................	„	60	0	0
„ Permanganate	per lb		4	0
„ Prussiate, Yellow	„		1	10
„ Sulphate, 90%	per ton	40	0	0
Sodium Metal	per lb.		1	3
„ Acetate	per ton	62	0	0
„ Arsenate 45%..............	„	48	0	0
„ Bicarbonate	„	9	10	0
„ Bichromate	per lb.		1	2
„ Carbonate (Soda Ash)...	per ton	10	0	0
„ „ (Crystals) ...	„	4	5	0
„ Chlorate.....................	per lb.			8
„ Hydrate, 76%	per ton	23	10	0
„ Hyposulphite	„	16	0	0
„ Nitrate, 95%...............	„	22	0	0
„ Phosphate	„	25	10	0
„ Prussiate.....................	per lb.			8½
„ Silicate	per ton	12	0	0
„ Sulphate (Salt-cake)......	„	3	0	0
„ „ (Glauber's Salts)	„	3	10	0
„ Sulphide.....................	„	22	0	0
Sulphur, Roll..........................	„	24	0	0
„ Flowers.....................	„	24	0	0
Sulphuric Acid, Non-Arsenical... 140°T.	„	5	0	0
„ „ „ 90%	„	7	5	3
„ „ „ 96%	„	9	7	6
Superphosphate of Lime, 18%...	„	5	0	0
Tartaric Acid..........................	per lb.		3	5
Zinc Chloride	per ton	25	0	0
Zinc Sulphate	„	22	0	0

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	June 7 1918 £ s. d.	June 8 1919 £ s. d.
RAND		
Bantjes	2 6	[illegible]
Brakpan	4 15 [illegible]	[illegible] 1 0
Central Mining (£8)	7 18 [illegible]	9 10 [illegible]
Cinderella	4 0	5 [illegible]
City & Suburban (£4)	16 3	15 [illegible]
City Deep	3 1 3	3 0 0
Consolidated Gold Fields	1 1 [illegible]	2 0 [illegible]
Consolidated Langlaagte	17 6	1 1 6
Consolidated Main Reef	15 [illegible]	[illegible]
Consolidated Mines Selection (10s).	1 7 0	1 6 [illegible]
Crown Mines (10s.)	1 18 9	2 5 0
Daggafontein	1 7 [illegible]	1 8 0
D. Roodepoort Deep	1 6	10 0
East Rand Proprietary	2 6	6 0
Ferreira Deep	13 0	13 6
Geduld	1 18 9	[illegible] 1 0
Geldenhuis Deep	13 [illegible]	12 6
Gov't Gold Mining Areas	3 15 9	5 0 [illegible]
Heriot	1 0 6	16 [illegible]
Jupiter	5 0	5 6
Kleinfontein	14	14 6
Knight Central	5 0	7 0
Knight's Deep	8 0	9 0
Langlaagte Estate	14 0	1 1 0
Meyer & Charlton	4 15 0	5 0 [illegible]
Modderfontein (£4)	[illegible] 0 0	[illegible] 0 0
Modderfontein B	7 13 9	8 10 0
Modder Deep	7 10 0	7 15 0
Nourse	17 6	17 0
Rand Mines (5s.)	2 15 0	3 5 0
Rand Selection Corporation	4 15 0	4 0 0
Randfontein Central	11 0	14 0
Robinson (£5)	15 6	13 6
Robinson Deep A (1s.)	1 3 9	18 9
Rose Deep	19 6	19 0
Simmer & Jack	5 6	5 6
Simmer Deep	2 9	3 0
Springs	3 17 0	2 19 0
Sub Nigel	1 10 0	1 7 6
Van Ryn	1 1 3	18 0
Van Ryn Deep	3 11 3	3 13 9
Village Deep	19 6	17 6
Village Main Reef	12 0	14 0
Witwatersrand (Knight's)	1 5 0	1 3 9
Witwatersrand Deep	7 0	13 6
Wolhuter	5 0	4 6
OTHER TRANSVAAL GOLD MINES:		
Glynn's Lydenburg	19 6	1 2 0
Sheba (5s.)	9	1 6
Transvaal Gold Mining Estates	15 6	15 6
DIAMONDS IN SOUTH AFRICA		
De Beers Deferred (£2 10s.)	12 17 6	22 0 0
Jagersfontein	4 1 3	6 5 0
Premier Deferred (2s. 6d.)	6 15 0	7 15 0
RHODESIA		
Cam & Motor	12 6	5 0
Chartered British South Africa	15 0	1 2 6
Eldorado	7 3	5 3
Falcon	1 2 3	13 9
Gaika	15 6	16 6
Giant	7 0	7 3
Globe & Phœnix (5s.)	1 9 6	1 5 0
L[illegible]ly Reef	1 16 6	2 15 0
Rezende	4 2 6	5 7 6
S[illegible]	1 18 9	1 18 9
W[illegible]	1 0	1 0
W[illegible]	4 9	6 9
WEST AFRICA		
Abbontiakoon (10s.)	[illegible] 6	5 0
Ab[illegible]	7 6	7 0
Ashanti (4s.)	[illegible] 6	1 4 0
Prestea Block A	[illegible]	4 [illegible]
Taquah	1[illegible] 6	17
WEST AUSTRALIA		
Associated Gold Mines	[illegible] 0	4 [illegible]
Associated Northern Blocks	2 9	3 [illegible]
Bullfinch	[illegible] 0	1 [illegible]
Golden Horse-Shoe (£5)	[illegible] 3 [illegible]	1 15 0
Great Boulder Proprietary (2s.)	11 [illegible]	11 0
Great Fingall (10s.)	1 6	1
Ivanhoe (£5)	1 15 0	1 17 6
Kalgurli	9	11 6
Sons of Gwalia	9	7 0

GOLD, SILVER cont.	June 7 1918 £ s. d.	June 8 1919 £ s. d.
OTHERS IN AUSTRALASIA		
Mount Boppy, New South Wales	2 0	2 [illegible]
Talisman, New Zealand	15 0	12 6
Waihi, New Zealand	1 16 9	2 3 9
Waihi Grand Junction, New Z'lnd	15 0	14
AMERICA:		
Alaska Treadwell (£5), Alaska	10 0	1 12 6
Buena Tierra, Mexico	13 0	1 1 3
Camp Bird, Colorado	10 6	1 2 0
Casey Cobalt, Ontario	9 0	3 [illegible]
El Oro, Mexico	9 0	1 3 0
Esperanza, Mexico	9 3	16 6
Frontino & Bolivia, Colombia	12 6	10 0
Le Roi No. 2 (£5), British Columbia	7 0	11 3
Mexico Mines of El Oro, Mexico	5 10 0	7 10 [illegible]
Oroville Dredging, California	19 3	1 8 0
Plymouth Consolidated, California	1 2 6	1 6 3
St. John del Rey, Brazil	16 6	19 0
Santa Gertrudis, Mexico	15 0	1 8 6
Tomboy, Colorado	17 0	16 6
RUSSIA:		
Lena Goldfields	1 5 0	1 15 0
Orsk Priority	12 6	15 0
INDIA		
Balaghat	4 6	4 3
Champion Reef (2s. 6d.)	5 9	5 [illegible]
Mysore (10s.)	2 11 3	2 0 [illegible]
North Anantapur	4 0	3 6
Nundydroog (10s.)	1 2 9	18 [illegible]
Ooregum (10s.)	18 3	16 [illegible]
COPPER:		
Arizona Copper (5s.), Arizona	2 6 3	1 17 6
Cape Copper (£2), Cape Province	2 10 0	2 5 0
Chillagoe (10s.), Queensland	1 3	1 6
Cordoba (5s.), Spain	2 6	1 3
Great Cobar (£5), N.S.W.	2 0	1 6
Hampden Cloncurry, Queensland	1 6 6	17 0
Kyshtim, Russia	17 6	1 17 6
Messina (5s.), Transvaal	8 0	5 0
Mount Elliott (£5), Queensland	3 5 0	3 10 0
Mount Lyell, Tasmania	1 7 6	1 2 6
Mount Morgan, Queensland	1 10 0	1 3 0
Namaqua (£2), Cape Province	1 15 0	1 17 6
Rio Tinto (£5), Spain	66 10 0	59 0 0
Sissert, Russia	17 6	1 3 0
Spassky, Russia	18 9	1 15 0
Tanalyk, Russia	18 6	2 5 0
Tanganyika, Congo and Rhodesia	3 3 0	4 12 6
Tharsis (£2), Spain	6 12 6	5 5 [illegible]
LEAD-ZINC:		
BROKEN HILL		
Amalgamated Zinc	1 7 3	1 3 6
British Broken Hill	2 9 3	1 17 6
Broken Hill Proprietary (8s.)	3 11 6	2 4 3
Broken Hill Block 10 (£10)	1 17 0	1 7 6
Broken Hill North	3 3 0	2 7 0
Broken Hill South	11 2 6	2 5 0*
Sulphide Corporation (15s.)	1 8 9	1 1 6
Zinc Corporation (10s.)	1 7 6	1 1 6
ASIA		
Burma Corporation	4 5 0	6 15 0
Irtysh Corporation	18 0	2 4 6
Russian Mining	8 6	1 2 6
Russo-Asiatic	2 2 6	5 5 0
TIN:		
Aramayo Francke, Bolivia	2 6 3	3 10 0
Bisichi, Nigeria	15 6	15 0
Briseis, Tasmania	6 0	14 9
Dolcoath, Cornwall	11 9	13 0
East Pool, Cornwall	1 9 6	17 6
Ex-Lands Nigeria (2s.), Nigeria	2 6	3 0
Geevor (10s.) Cornwall	1 3 6	19 [illegible]
Gopeng, Malay	1 17 6	2 6 [illegible]
Ipoh Dredging, Malay	18 0	1 3 0
Malayan Tin Dredging, Malay	2 2 6	2 10 0
Mongu (10s.), Nigeria	16 6	19 [illegible]
Naraguta, Nigeria	18 0	17 [illegible]
N. N. Bauchi Pref. (10s.), Nigeria	12 9	12 0
Ord. (10s.)	7 6	7 0
Pahang Consolidated (5s.), Malay.	13 0	17 [illegible]
Rayfield, Nigeria	1 9	15 0
Renong Dredging, Siam	2 2 6	2 5 0
Ropp (4s.), Nigeria	1 5 0	1 3 9
Siamese Tin, Siam	3 0 [illegible]	3 6 3
South Crofty (5s.), Cornwall	2 12 0	1 10 [illegible]
Tekka, Malay	3 15 0	4 5 [illegible]
Tekka Taiping, Malay	3 15 0	5 0 0
Tronoh, Malay	1 15 0	1 18 9

* Share capital expanded.

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

THE HEIDELBERG GOLDFIELDS

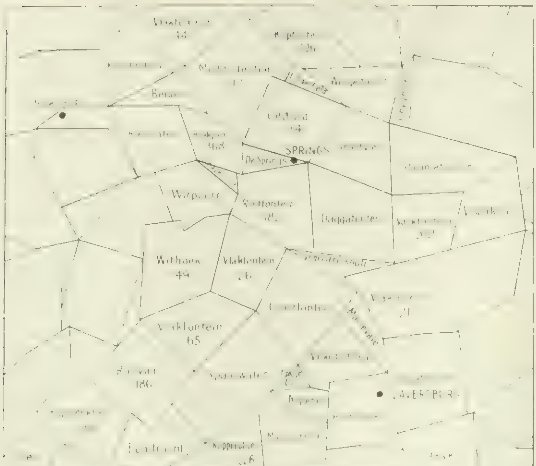
During the past two or three years the possibilities of the southern portion of the Far East Rand have received keen attention. Twenty to thirty or more years ago much used to be heard of the Heidelberg goldfields, and at the beginning of the present century there was an abortive boom in connection with the Coronation Reef about 15 miles south-east of Heidelberg. The gradual extension of workings in the basin of the Far East Rand has brought Heidelberg once more within the sphere of the prospector. The Consolidated Gold Fields has led the way in connecting Heidelberg with the Far East Rand by starting work from the Sub-Nigel to the Grootfontein in a north-westerly direction. They have also taken an interest in the Southern Van Ryn company. The Barnato-Bailey group has acquired control of the Lace properties, Vlakfontein and Spaarwater, and when opportunity offers will commence development. Thus the area will be bridged from Brakpan and Modderfontein to Heidelberg and Nigel. A number of other financial houses are undertaking the prospecting of properties between Nigel and Heidelberg, and also to the west and south-west of Heidelberg. In connection with the finance of these operations, and also in connection with the geological theory, the name of Mr. W. E. Bleloch appears prominently. As we have said on previous occasions, Mr. Bleloch's theories are unorthodox. But the correlation of the various reefs does not matter so much as their payability.

The *South African Mining and Engineering Journal* has been publishing a series of articles on the present operations at Heidelberg, together with an outline of the history of the goldfield, commencing with the issue of March 1. We make extracts from these articles herewith.

Briefly stated, Mr. Bleloch's thesis is that the auriferous bankets commonly known as the Main Reef Series, which are worked in the Central Rand and which may be followed with little interruption or displacement in a relatively ordered and consistent sequence from Roodepoort to Boksburg, are distinct from the reefs lying to the west of the Witpoortje break in the far west Rand and from the reefs lying to the east of the Boksburg line of faulting between East Rand Proprietary and Kleinfontein. These latter reefs, or at any rate those portions of them which are profitably worked, he identifies under the head of the Van Ryn series. In other words, Mr. Bleloch correlates the series worked at Randfontein, the old so-called West Battery and Botha series and the reefs worked in the French Rand, with the conglomerate beds which have been turned to such profitable account during recent years by the New Modderfontein, Government Areas, Springs, and other Far East Rand companies. These he regards as one and the same series, namely, the Van Ryn, and he does not confuse them with the Main Reef Series of the Central Rand proper or with the Nigel Reef, each of which he regards as a distinct and separate geological development. The Nigel is assigned to a horizon considerably below that occupied by the highly profitable and consistent Van Ryn series, that is, it underlies it. It therefore follows that Mr. Bleloch's contention assumes the existence of two payable reef series in the Heidelberg area, namely, the top or Van Ryn section, and the bottom or Nigel section. He contends that these two reef series have a very persistent development on the Farther East Rand, that they sweep southward through the Southern Van Ryn and Sub-Nigel properties and the Heidelberg town lands, and are to be found in the Malan's Kraal-Riet fontein-Tweefontein-Wilgepoort-Daspoort syncline to the south of the old Coronation line of development and in proximity to the township of Balfour and the Natal railway line.

In Mr. Bleloch's estimate the reef encountered in one of the bore-holes at Daggafontein at a depth of 1,946 ft., assaying 31 dwt., was in the Van Ryn horizon, and that a continuation of this bore-hole cut the Nigel series. He supports his reading of the stratigraphy of the Farther East Rand section by a weighty mass of correlative petrology and stratigraphy.

Up to the outbreak of the Boer war one Heidelberg company only produced gold and earned dividends, the Nigel. There were numerous flotations, but the Nigel alone made any mark as a producer. Just before the signing of the Vereeniging Treaty, the line of reef taken up by the Coronation Syndicate came into prominence. The Coronation Syndicate was promoted by Carl Hanau, and backed by the Barnato group. John Harry Johns' report identified the reefs worked there with the Main Reef Series, resulting in the booming of the shares and the flotation of many other propositions on the supposed line of the Coronation Reef. These concerns called for the serious attention of the *South African Mining Journal*, and anyone who cares to wander through the back volumes of the paper will find much that is instructive and sometimes much that is amusing in regard to geological beliefs that have been tried more or less and found wanting. In the very first issue of the *Journal* published after the war the affairs and prospects of the Federation Syndicate were dealt with at considerable length. Mr. Bleloch was a director of this syndicate. Minett Frames and Harry D. Griffiths, the geological sponsors of this flotation, formulated the theory that the Coronation Reef did not belong to the Main Reef Series, "but that its proper position is among the topmost beds of the Rand and that it will be found in the horizon immediately underlying the amygdaloid." Frames and Griffiths correlated the Coronation Reef with the Steyn Estate Reef on the farm Doornkop in the far west Rand. This assignation was not, however, to be considered as a reflection on the intrinsic merits of Coronations. Frames and Griffiths, on the contrary, believed that there were highly profitable values to be extracted from the banket beds immediately underlying the amygdaloidal diabase beds which were, and are still, more commonly known as the Elsburg series. The Elsburg Reefs have never been a material factor in Rand gold-mining industry, but the Federation Syndicate promoters believed that they had never had a fair trial, and accordingly they acquired options over 25,000 morgen of land in the



Map of Far East Rand and Heidelberg Districts

Giving the names of the Farms.

Heidelberg district with a view to demonstrating the accuracy of the Frames-Griffiths school of thought. The geological premises were backed by a considerable bulk of evidence, mainly in the form of reef sections obtained over widely-separated areas and which exhibited similarity of mineralogical structure.

It was not until September, 1904, that Dr. Corstorphine pricked the Coronation bubble, and in stating that the reef in Edenkop on Rietfontein 72 was not in his opinion on the Main Reef horizon confirmed one item of the stratigraphical fabric upon which Federations went to flotation.

In April, 1904, Dr. Corstorphine issued a report which tentatively supported the pronouncement of John Harry Johns that Coronation and Main Reefs were identical. "With the steep dip which prevails on Edenkop," wrote Dr. Corstorphine, "the Reef is high enough above these slates (underlying striped slates) to justify its being regarded as on the Main Reef horizon." This remark, coupled with the encountering of profitable values in portions of the Edenkop mine, was quite sufficient to further inflate the value of the Coronation line of propositions, and in the earlier part of 1904 there was extraordinary activity in the Heidelberg area. Federations, however, took but little part in this epoch of activity and bounding prices. Shortly after the flotation of Federations in the early part of 1903, public interest seems to have been temporarily deflected to the northern part of the Orange River Colony (as it then was) by the sudden appearance of the Main Reef series in the properties of the Orangia Main Reef and in the valley of the Kromelleboog River with no less a sponsor than the celebrated Dr. Molengraaf. Great interest was also evinced at that time in the Gemsbokfontein strike by the Western Rand Estates. All the while, however, Heidelberg and the districts lying to the south-east were being busily prospected.

Rathbone's South African Syndicate and the Mines and Minerals Exploration Syndicate were working on the Heidelberg town lands. The New Colonies and New Transvaal Companies had taken up large areas towards Ermelo. Hex River was being prospected, and the Coronation Victory, Coronation Freehold, etc., were supposed to be on the right line of country. A diamond-drill was started on Daspoort, and the encountering of good values in the Coronation Mine increased Carl Hanau's already unbounded optimism. By the middle of 1904 work was at its zenith, not only along the Edenkop line but also in the subsidiary syncline, Wilgepoort, Daspoort, and Tweefontein, etc. But the authoritative announcement that the Coronation was not on Main Reef horizon and that continuity was not to be expected, coupled with the fact that the shafts and drills and drives of Mr. Hanau's sensational flotation encountered broken ground and poor values, very soon sounded the death-knell for the district. There were, however, sporadic outbursts of activity and periods of optimism, and the Molyneux and Hex River properties for a while attracted a little attention.

All this time the preliminary development of the great Farther East Rand goldfields had been proceeding, and in 1904 Dr. F. H. Hatch, who had made a close study of drilling operations in the area between Boksburg and Nigel, read a noteworthy paper before the Geological Society of South Africa which adduced evidence for the correlation of the Nigel with the Main Reef. "The evidence I offer," said Dr. Hatch, "is as follows: (1) The two reefs occupy the same geological horizons; by this I mean that they both rest on the highest bed of slates of what I have throughout this paper designated as the Lower Witwatersrand beds. They are both overlain by an identical sequence of beds belonging to the Upper Witwatersand beds. These include the amygdaloidal diabase, the Kimberley basement slates, and the Kimberley series of conglomerates. That these beds exist in the same order in the Nigel districts as they do in the Springs district is shown by the Groot fontein bore-hole put down by the Consolidated Gold Fields, 12,000 ft. north of the outcrop of the Nigel Reef, which cut these three markers. (2) The course of the reef under the overlying dolomite and Karroo beds has been traced by the following series of bore-holes, Geduld (Nos. 1, 2 and 3), Grootvlei (Nos. 1 and 2), Vlakfontein and Grootfontein (Central Nigel Deep Joint). The above evidence clearly shows to my mind that in the Nigel Reef we have the continuation of the Van Ryn Reef, and consequently of the Main Reef of the Central Rand."

Dr. Hatch's paper naturally attracted a great deal of interest and provoked a large amount of discussion. Of the critics, the most eminent was the late Dr. Carrick. During the discussion Dr. Carrick drew attention to an interesting fact, namely, that No. 2 bore-hole on the town lands of Heidelberg, in his opinion, undoubtedly intersected the Nigel Reef at a depth of 1,943 ft., from the surface, approximately 1,500 ft. below a highly payable reef, such as is nowhere known to exist on the East Rand in the Kimberley series; that is to say, that there were two horizons, one 1,500 ft. below the other, which carried good values, the lower of the two corresponding in Dr. Carrick's view to the Nigel Reef. This occurrence was instanced as a strong argument against the Nigel Main Reef correlation theory.

In December, 1905, Dr. McClelland Henderson dealt with Dr. Carrick's views. Dr. Henderson, in the course of his paper stated: "As recent developments on Daggafontein have shown, however, here also are two reef horizons, the one approximately 1,500 ft. below the other, the lower of which is clearly proved by the evidence outlined in this paper to belong to the Main Reef Series; so that if these two reef horizons correspond to those encountered in the town lands of Heidelberg, then according to Dr. Carrick's own argument, the Main Reef and the Nigel Reef, both constituting the lower horizon, are in that case identical. Summarizing, as a result of recent exploration in the East Rand, it appears to me that the following facts are established, affording additional proof as to the identity of the Nigel and Main Reefs. (1) The continuity of the Witwatersrand beds has now been proved southwards for 3½ miles across Daggafontein to within 5½ miles of the Grootfontein Central-Nigel Deep joint bore-hole, in which the presence of the same Witwatersrand beds was observed on the dip of the Nigel Reef (2) The bore-holes on the Daggafontein demonstrate that perfect regularity in the sequence of the upper Witwatersrand beds is maintained as far south as the boundary of Vlakfontein No. 21. (3) Two bore-holes (Daggafontein No. 3 and 5) have now proved that a rich banket may be found in the Kimberley series, thus over-ruling the objection that the Nigel and the Main Reefs could not be identical because a rich banket was intersected 1,500 ft. above the Nigel Reef in the town lands of Heidelberg. (4) That it is the Kimberley series in which Daggafontein bore-holes No. 3 and 5 have encountered this banket is proved by the evidence deduced from the sequence of strata, supported by the macroscopic features and microscopical examination showing the characteristic abundance of rutile in the Kimberley basement slates."

In 1906, Sir (then Mr.) Drummond Chaplin had nothing cheering to say about the Central Nigel Deep, and in that year, too, the Federation Syndicate was considering liquidation.

Right up to early in 1909 when South Africa in general and the Witwatersrand in particular began to recover from the effects of over-speculation and the incorrigible optimism which marked the conclusion of the Boer War, the Heidelberg areas were out of fashion and repute. The first whispers of a re-awakening activity in the area appear to be connoted by statements to the effect that the Sub-Nigel company had the acquisition of a larger claim area in prospect. These statements were in circulation in the early part of 1909, and in December of that year the undertaking of the Nigel Deep, comprising 514 claims, 30 stamps, cyanide plant, etc., was acquired for 147,580 fully paid shares. The enlarged Sub-Nigel company commenced crushing on December 18, 1909, on taking over the Nigel Deep property and equipment, and the output of the concern during the next year was 18,199 oz.

It was not until just before the European War that any real measure of interest appears to have been reawakened in the Heidelberg area. At the end of 1912 the Sub-Nigel entered the dividend list, and at the beginning of 1914 attention was drawn to the fact that there was much pegging activity in the Nigel district and that a considerable number of claims had been acquired. During 1914 the Sub-Nigel company increased its claim holding. In the subsequent year there occured an event which was fraught with a very considerable measure of importance for the whole Eastern Rand. Dr. Mellor, of the Geological Survey, read a paper which was at the time described as a classic, in which he made public the results of his investigations into the geological structure and stratigraphical relationship of the country which extends to the east and south-east of Boksburg.

Dr. Mellor, who is now consulting geologist to the Central Mining and Investment Corporation, was the Acting Government Geologist when this paper was read. Dr. Mellor's pronouncements, in the minds of many people, set the seal on the theory of the identity of Nigel, Van Ryn, and Main Reef Leader. In the course of his paper Dr. Mellor stated that the remarkable continuity of the so-called Black Bar, among other beds of the Main Reef section, had enabled him to conclude without hesitation that the Main Reef Series extends from the Central Rand to the mines of the Far East, and that what is known in that area as the Main Reef, in the Kleinfontein and other properties, is the Main Reef Leader of the Central Rand, while the shale foot-wall is the Black Bar in one or other of its mod fied forms. In other words the view of the Geological Survey, as expressed by Dr. Mellor, was that the Main Reef of the Blue Sky, New Boksburg, Van Ryn, Apex and Kleinfontein, Government Areas, Springs Mines, etc., areas is unquestionably a portion of what is known as the Main Reef Series of the Central Rand, and that the ore-body usually spoken of as the Main Reef in the Far East is to be correlated with the Main Reef Leader of the central mines, while the Main Reef itself has practically disappeared in the more distant field.

(To be continued)

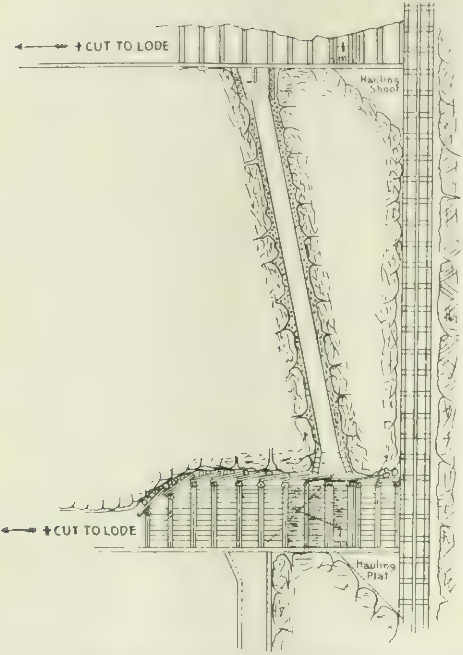


Fig. 1. General Arrangement of Underground Ore Bins.

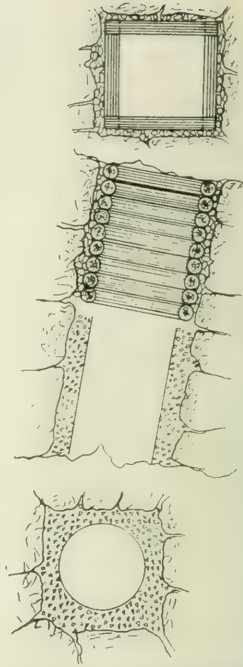


Fig. The upper half shows the Timbered Ore-Bin and the Lower half of the Concrete Ore-Bin.

USE OF CONCRETE AT WALLAROO & MOONTA.

Chemical Engineering and Mining Review (Melbourne) for February contains an article describing the use of concrete at the Wallaroo copper mine of the Wallaroo & Moonta Mining & Smelting Co., South Australia. Swelling of ground and consequent crushing of shaft timbers led to the experiment of lining a section of the shaft with reinforced concrete. This departure has reduced the cost of maintenance and facilitated ore raising. Concrete is also used for lining underground storage bins.

Mining operations are carried on through two vertical main shafts, Taylor's 2,980 ft., and Young's about 2,660 ft. deep, situated 1,420 ft. apart on the same lode. Levels are opened at intervals of 120 ft., measured vertically. The deepest drive from Taylor's is the 2,910 ft., while at Young's the bottom level is 2,550 ft. from the surface. The great depth of the main workings renders special provision for ventilation necessary, and an extensive scheme has been completed. In this system the currents from the surface travelling through the downcast (main) shafts are regulated by numerous doors, ensuring the cooler air available reaching the working faces, while to increase the volume circulating three old shafts have been deepened and equipped at the surface with electrically-driven exhaust fans of large capacity. The present depths of these ventilating shafts are: Boor's 2,310 ft., Office 2,070 ft., and Hughes 1,470 ft., while passes through the worked-out ground, winzes, etc., serve as thoroughfares for the heated air from the lower workings to reach the inlets to the fan shafts.

The lode course is fairly continuous for a length of about 2,000 ft., but the distribution of values is erratic, the payable ore occurring in lenses separated by unproductive bars. The country rock is a metamorphic micaceous schist, and the lode material consists of altered mica schist impregnated with quartz carrying chalcopyrite, pyrite, and pyrrhotite, the ore-bodies varying from 4 ft. to over 20 ft. in thickness, with an average stoping width of about 9 ft. Both the country rock and lode material swell when exposed to the atmosphere, and at the deep levels, although the ground is usually firm when first opened, within a short time it commences to expand, this movement being sufficient to ultimately crush the heaviest supporting timbers, and these have to be frequently renewed in all the more important workings. As a consequence of the constant repairs required to the timbers lining the principal shafts, the time available for hoisting and sending material underground is restricted. Under these circumstances to provide storage for the broken ore near

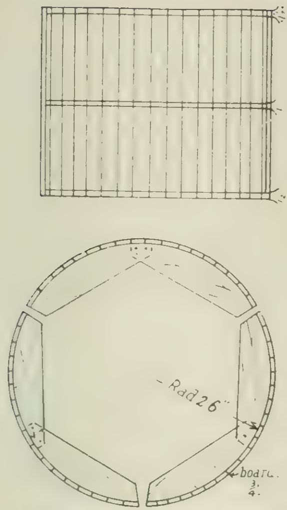


Fig. 3 Forms used in Concreting Underground Ore Bins

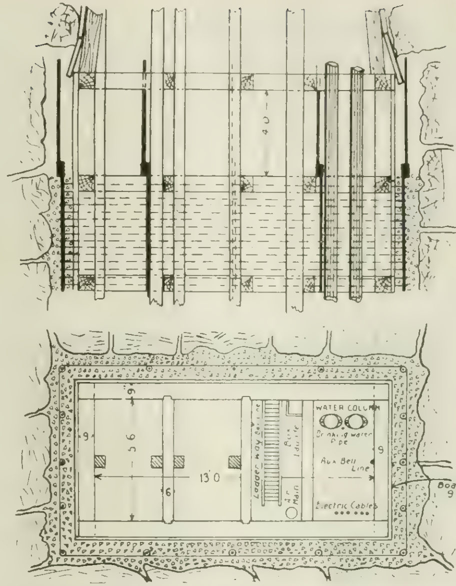


Fig. 4 Taylor's Shaft with Concrete reinforcing the Timbers.

the shafts and secure the highest practicable efficiency during hoisting operations an extensive system of underground storage bins has been provided at both main shafts.

The relation of these bins to the shafts and the general arrangement is shown in Fig. 1. In their construction, winzes are sunk 5 ft. by 5 ft. within timbers, commencing from a point in one cross-cut at such an inclination that they can be equipped at each level with discharge chutes, emptying either into the shaft hauling bin from which the skips are loaded, or into the next bin below. The original practice was to remove the timber, leaving the ground unsupported, but it was found under these conditions the sides caved so badly that some method of securing them had to be devised. A number were lined with circular steel tubing, 3 ft. 6 in. in diameter, the space between the tubes and timber being tightly packed with waste rock. These tubes were rolled from one half-inch plate, reinforced with heavy angle iron and made in two sections for convenience in handling. They gave generally satisfactory results, but latterly, owing to the scarcity and heavy cost of suitable plates, the bins have been lined with cement concrete as shown in Fig. 2.

From experiments made it was ascertained that for the concrete lining to successfully resist the abrasive action of the coarse ore tipping into an empty or partially empty bin, it was expedient to use a fairly rich mixture. The composition is one part of cement, two parts of sand, and three parts of rock crushed to pass a 2 in. ring, and the minimum thickness of the concrete is about 10 in. With this method the bins are made 5 ft. in diameter, the forms being constructed in three segments, as shown in Fig. 3, and the timbers used to secure the sides during sinking are removed, the concrete supporting the ground. When the forms are taken out, several weeks are allowed for the lining to dry before placing the bin in commission

As already stated, the repairs due to the swelling ground are particularly heavy in connection with the main shafts, and for a considerable period after a section is constructed a large proportion of the timbers has to be frequently renewed. Usually after six or seven years, however, the movement of the surrounding rock gradually decreases, although in some portions, where the ground is divided by fault planes, the swelling action is prolonged, due to the divisions in the rock allowing air and moisture to penetrate further into the sides of the shaft.

The shafts are timbered with sawn Tasmanian hardwood sets, the ordinary sets being 9 in. by 9 in., while the principal timbers in the opening-out sets at the levels are 12 in. by 12 in. square.

The successful application of concrete to other purposes having shown its suitability for supporting excavations, at Taylor's shaft a section of the timbers about 40 ft. high, has recently been reinforced with cement concrete. This work was carried out above the 2,430 ft. level where a slide enters the shaft, making the ground so heavy that almost constant repairs have been needed to the timbers since this portion was constructed about seven years ago. As a result of the side pressure the shaft had been forced nearly 18 in. out of alignment, which necessitated removing the old timbers, as well as sufficient ground behind the sets to give room for the concrete and straightening the shaft. The new timbers were erected in the position required to make the shaft properly vertical, and these, lined with boards, served as forms. Owing to the nature of the rock it was only practicable to remove one set of old timbers at a time, and as soon as the new frame was in position this was filled with concrete consisting of one part of cement, four parts of sand, and four parts of rock crushed to pass through a 2 in. ring. These were sent underground in separate lots, mixed at the nearest level, and passed to the required points through wooden pipes. For reinforcing, old drill steel was used for vertical bars, and strands of worn-out hoisting rope, previously annealed, as horizontal binding. The arrangement is shown in Fig. 4.

The added strength obtained by using concrete is at least fifteen times that of the Tasmanian hardwood sets, and the ground is also protected from the effects of the atmosphere and moisture, which would materially assist in preventing movement. The rock removed at the eastern end of the shaft had to be worked away without blasting, and the utmost care exercised to prevent injury to the electric cables conveying power to the drainage pumps, as well as the air and water mains. In order to provide the required output, it was necessary to continue using the shaft for general hoisting purposes, and the renewals and concreting were carried out during the week-ends when mining operations were suspended.

THE SULPHIDE CORPORATION'S SMELTING PLANT.

The annual meeting of the Australasian Institute of Mining Engineers for 1918 was held last August at Newcastle, New South Wales. Copies of papers read at that meeting only reached this country last month. Among these we find a number relating to the metallurgical and chemical processes employed at the Cockle Creek works of the Sulphide Corporation. This company owns the Central mine at Broken Hill, and sends its lead concentrate by sea to the works at Cockle Creek. These works were established in the neighbourhood of coal mines and coke ovens rather than at the mine or on Spencer Gulf. The company also does a large amount of custom smelting.

We reprint herewith descriptions of the smelting plant, written by Guy Courtney, and of the sintering process, written by W. J. Jackson. Papers on other departments will be quoted in our next issue.

Smelting.—The smelting equipment consists of three blast-furnaces, supplied with blast from two sets of vertical piston blowers, each capable of delivering 8,000 cub. ft. of air per minute at a pressure of 60 oz per sq. in. Each blower is belt-driven by a 130 h.p. motor. The maximum speed of the blowing engine is 35 r.p.m. No. 1, the largest of the three blast-furnaces, has a crucible area of 49·5 sq. ft., and measures 11 ft. 6 in. by 5 ft. at the tuyeres, from tapping floor to feed floor 35 ft. 9 in., and holds, when full, 100 tons of charge. Blast enters through thirteen 3 in. tuyeres at 60 oz. pressure. Working normally, this furnace is capable of treating 300 tons of charge, exclusive of returned slag and coke, per 24 hours, with an output of 100 tons of lead. Tapped slag flows into a C.I. forehearth mounted on wheels, where any lead and matte is caught, and the slag overflows into a 3 ton cast-iron pot, in which it is drawn away by an electric locomotive and poured over the dump. Forehearths are replaced several times a shift, the full ones being taken to the matte shed, where they are drained of matte and lead, and the shells knocked out. Any slag tapped out of these forehearths, together with the shell, is returned to the blast furnace.

No. 2 blast-furnace measures 8 ft. 2 in. by 4 ft. 4 in. at the tuyeres, has a crucible area of 29·3 sq. ft., and is 34 ft. high from tapping floor to feed floor. Blast is delivered through nine 3 in. tuyeres at 55 oz. pressure. This furnace has a capacity of 250 tons of charge in 24 hours. The forehearth is similar to that already mentioned. No. 3 blast-furnace measures 5 ft. 6 in. by 2ft. 9 in. at the tuyeres, and has a crucible area of 15 sq. ft This furnace is chiefly used for smelting drosses and antimonial slags from the refinery. In all cases the slag is taken out to the dump in the same type of slag-pot, and by the same means of locomotion.

The charging arrangements consist of a series of bins, six in number, situated conveniently at the back of No. 1 furnace, and connected with all three furnaces by a 2 ft. gauge tramway system.

Two jaw-breakers reduce all materials to about 4 in. mesh, and feed two bucket elevators, which lift the fluxes and ores to the bin top, and deliver by means of movable chutes into any required bin. When full, there is enough material to last the large furnace for about 36 hours. A gang of men, working day shift only, keeps the bins charged. Each bin is provided with a hopper scale, the hopper of which is divided down the centre into two compartments, so that on opening the bin door the material is split by the partition into two approximately equal parts, equivalent to two or four charges, according as to whether the total charge has been weighed out for four or eight charges. By weighing the charges in this way, the element of error is reduced to a very small figure.

Running underneath the scale hoppers is a 3 ft. track, on which travels a special type of charge truck, divided into four compartments by plates at right angles to one another. In order to facilitate the discharge of the fluxes, the truck is constructed on the saddle-back principle, and has a door to each of the four compartments. It is, therefore, possible to wheel four charges at once, and to discharge them independently of one another.

From the flux truck the charge goes into a set of four tilting hoppers, built to the level of the floor, and over a pit in which is the truck for hauling the complete charge to the top of the furnace. These hoppers are tilted by means of hydraulic rams operated by control levers. The flux line runs down the centre of the hoppers, while the Huntington - Heberlein product is brought to either side and crosses at right angles to the flux line.

The H. H. mixture, which constitutes three-quarters of the full charge, is hauled from the H. H. pot-house by electric locomotives. A rake of 10 trucks, equivalent to ten charges, is brought up and run over a weighbridge, where the weight is adjusted. It is then taken on to the charge-making floor and left in position for the charge-makers to handle.

The making-up of a charge is as follows: The flux truck is run under the scales and placed in such a position that the flux, on discharging from the scale hoppers, will split either into two or four charges, as required. Having carried out this operation with all the required fluxes, it is run down to the four tilting hoppers, and one compartment discharged into each, a charge of coke having previously been placed in the bottom. A truck of the H. H. product is then brought up and its contents dumped in, after which follows a truck of returned slag from the matte shed, consisting of slag-pots and forehearth shells. The returned slag cars are of a similar construction to the flux wagon, except that they are not divided into four compartments, but only into the two made by the saddle

Having completed the charge, the tilting hopper discharges into a charge truck beneath. This truck is hauled up an inclined way to the top of the furnace by electrical power, and so arranged that, as a full truck goes up, an empty one descends on the other side. On arrival at the furnace feed floor, the feeder releases a catch, and the hopper, being slightly top-heavy, turns completely over, discharging its contents into the furnace.

The Sulphide Corporation being a custom smelter, a large variety of ores have to be treated, resulting at different periods in furnace slags of varying composition. In consequence of this, it is difficult to give any definite type of slag run, but, as an illustration, the type being run at present is given below:

	%
Pb	0 7
FeO	36·4
MnO	1 6
CaO	17·2
SiO_2	24·5
ZnO	12 0

This slag, as before mentioned, is tapped into cast-iron elliptical pots and poured over the dump.

The lead is tapped into small cast-iron pots, and run across to the drossing furnace. This is a small reverberatory of about seven tons capacity, from whence two products are obtained, lead bullion (carrying most of the gold and silver) and dross. The dross, on being removed from the top of the lead, is still fairly "wet," and is transferred to a liquating furnace, where most of the lead is sweated out and returned to the drossing furnace. The more or less "dry" dross is allowed to accumulate till there is sufficient to warrant No. 3 furnace being blown in, and the accumulated stock smelted.

The lead from the drossing furnace is tapped into two rings of 100 moulds each, which revolve on their own axes. On cooling, the bars, which weigh about 85 lb. each, are stamped with a letter and number, in lots of 2,600 bars, or nearly 100 tons, and sent for treatment to the refinery. Lead matte, caught in the forehearths, is tapped into cast-steel moulds, set in a revolving ring, and from thence carted to the Krupp mills at the roasting plant, and crushed ready for incorporating in the H. H. mixture. Any lead found in the forehearths, which has not been previously tapped at the smelter, is cast into moulds and sent to the drossing furnace.

In order to remove the shells, the forehearth is run into a tipping cage, which turns upside down, when, by means of a bar, the forehearth shell is knocked out. The slag shells remaining in the slag cars, after the liquid contents have been poured over the dump, are also brought back to the matte shed, and tipped alongside the shells from the forehearth. A 3 ft. tramway runs through this building on a track sunk into the ground, so that the top of the return slag trucks are on a level with the main floor. The various shells are broken up, loaded into these trucks, and drawn to the smelter-charge hopper by an electric locomotive. The only slag which is added to the smelter charge is that sufficient to keep these shells worked up.

Sintering. All ores arriving at the works which contain more than 3% sulphur, together with all sands and other fine residues, are delivered to the roasting department. Those that are in a coarse condition are first sent to the crushing plant, consisting of 15 in. by 9 in. jaw crushers and two No. 5 Krupp mills. The ore is here crushed through a quarter mesh screen. Any pyritic concentrates high in sulphur are given a preliminary roasting, to bring the sulphur contents down to about 12%, and the roasted material is delivered to the H.H. charge-making bins. Here the various ores, sands, residues, roasted pyrites, together with about 12% of limestone, are made up into 1 ton charges in hopper trucks with bottom discharge. The trucks are elevated by hydraulic lifts to a tramway running over the roasting furnaces, and the contents are dropped into hoppers over each furnace, from whence the mixture is fed into the centre of each furnace by means of a Challenge ore-feeder.

A typical charge would contain:

	%
Pb	50
SiO_2	7
FeO	7·5
CaO	6
MnO	2·3
ZnO	10
S	15

The mixture is now given a roasting in a modified Godfrey furnace, which brings the sulphur contents down to about 9·5%. This furnace is gas-fired, and consists of a rotating circular hearth, 21 ft. in diameter, supported on a wheel race, and covered by a low, dome-shaped roof. The charge, as already stated, is fed into the centre of the furnace through a hopper with a Challenge feed, and worked outward by blades attached to a fixed radial arm. At each revolution it is turned over and outward, the amount of deflection of the blades, which are adjustable, and the rate of rotation of the hearth determining the output of the furnace. There are ten of these furnaces in two rows of five, each with an output of 30 tons per day (24 hours). They are driven by a duplicate steam engine of 18 h.p. (which allows of great variation of speed) off two main shafts by belt drives, each furnace requiring about 2½ h.p. One man looks after four furnaces. The object of the roasting in these furnaces is not only to reduce the sulphur contents down to about 9·5%, but also to agglomerate the fine particles so that the roasted material will be in a granular condition, which form is most suitable for the subsequent treatment in the H.H. pots

The gas for firing the roasters comes direct from the Mond gas plant, and is led into the brick combustion chamber of the furnaces through a gas burner, through which a number of air pipes pass. The gas and air thus become mixed as they pass into the combustion chamber. Fitted to the front of the box is a wrought-iron sliding plate, perforated with a number of holes coinciding with the air pipes leading through the box. As the sliding plate is worked backwards or forwards it opens or closes the air holes, thus regulating the supply of air to the combustion chamber. The supply of gas is controlled by a gate valve on top of the cast-iron box or burner.

The hot roasted ore is discharged at the periphery of the hearth into brick-lined boxes, which keep the material hot while sufficient is accumulating to fill one of the trucks, by which the roasted ore is conveyed to the H.H. pot-house. When sufficient ore has accumulated in the various boxes to make up a train-load, it is allowed to drop out of the hoppers into special side-tipping trucks, run on a 2 ft. gauge tram-line. These trucks are pushed out on to the main line, where they couple together automatically, and are hauled by a 5 ton electric locomotive up a 4% incline into the H.H. pot-house.

This plant consists of 24 pots, each capable of holding 5 tons. The charge floor is built up level with the top of the pots, which facilitates charging. The H.H.

pots are cast-iron of elliptical form, hung on hollow trunnions. About 6 in. from the bottom a perforated plate fits horizontally. This is held in position by four studs, which are fixed into the sides of the pot, and project about 1 in. over the top of the plate. The space under the plate acts as a wind-box. The air-blast passes through the hollow trunnion down a pipe outside the pot, and enters the wind-box. There is, therefore, no necessity for detaching and re-attaching the air pipe after each tipping of the pot.

A hood rests on the flanged edge of the pot, making a fairly close joint, which is made air-tight by a lute consisting of flue dust and clay. It is provided with two small doors or inspection-holes, through which the charge is barred when blow-holes make their appearance. They are also fitted with a telescopic arrangement, which allows the hoods to be easily swung up during charging or tipping operations. The hot roasted ore when it arrives at the pot-house, is tipped direct into the pots. The charge is levelled, and an air-blast of from 10 to 12 oz. pressure is turned on. Thermo-chemical action takes place. The ore is desulphurized to a low point, and the heat generated by the reaction is sufficient to fuse or sinter the mass, with the exception of a little fines on the top of the pot, which are returned to the raw mixture, and worked off in small amounts to each charge. It takes from six to eight hours to finish the operation. The pot is then turned over, and the sintered mass falls on to the breaking floor beneath. Here it is cooled by spraying with water, and broken up to 6 in. lumps.

One essential difference in the process from the general practice is that the charge, after roasting, is not wetted and cooled, but arrives at the H.H. pots at a dull red heat. No fire is built in the pot, the heat retained by the ore being sufficient to start the reaction when the blast is turned on, whereby there is a considerable saving in fuel and labour.

The gas pipes from the hoods connect with four main overhead pipes, two of which convey the gas suitable for acid-making to the acid chambers. The other two are used for by-passing the unsuitable gases to two iron stacks, which discharge into the atmosphere. As the operation develops, it is expected that the whole of the gases will be used for acid making, about 80% of the gases being serviceable for this purpose.

To one trunnion of each pot is fitted a wheel about 4 ft. in diameter, which has a heavy toothed boss. These teeth engage with a pawl, which holds the pot in position while working. When it is ready to tip, the pawl is knocked out, a chain is passed round the wheel, and the pot pulled over by means of a two-ton block-and-tackle. The sintered mass, weighing about four tons, falls on to the breaking floor, 10 ft. below. This floor, which stands about four feet above the surrounding level, has been built up by running in molten slag to a depth of six feet. The block has been covered with concrete, reinforced with 60 lb. railway irons laid side by side. These overhang by about one foot, and project just over the top of the side-tipping trucks, which stand on a line running each side of the breaking floor. This, together with the fact that the floor has a slight fall to each side, enables the sintered product to be easily pushed into the charge trucks. When full they are drawn away to the smelters by the five-ton electric locomotive already mentioned.

The blast for the H.H. pots is supplied through a 20 in. main from a Root blower, driven by a 60 h.p. variable-speed motor, the actual power required being about 30 horse-power.

Other papers will be quoted in the next issue.

H. K. PICARD ON ZINC AND LEAD METALLURGY.

As promised last month we give herewith extracts from the presidential address delivered by Mr. H. K. Picard before the Institution of Mining and Metallurgy on May 8. Owing to exigencies of space we confine these extracts to the portions of the address dealing with zinc and lead metallurgy. In our editorial columns we refer to some other points in his address.

There has not been any marked improvement of first importance in zinc smelting during recent years, though general advance in matters of detail may be recorded. The problem of the mechanical roasting of the ores cannot yet be considered as completely solved, especially for the more refractory types such as Broken Hill concentrates, which form so large a proportion of the world's supply of raw material. Though improvement has been effected in this direction, as exemplified by the Ridge and Spirlet furnaces, it is significant that in the latest zinc works to be erected in this country, the management has adopted the hand-rabbled Delplace furnace as being the type best suited to their requirements. These works, situated at Avonmouth, are being constructed by the National Smelting Co., and are designed for an ultimate output of 50,000 tons of zinc per annum. These, when completed, with extensions of other existing works, should go far towards establishing the industry in this country on a much sounder basis than existed before the war. No effort is being spared to make the Avonmouth works thoroughly efficient and up-to-date. The general lay-out is well designed, and provision is made for future extensions The pottery has a capacity of 45,000 retorts, and is arranged for convenient handling in and out; two hydraulic pot presses are to be installed (one of which is already erected), which will supply the retorts for the 16 retort furnaces contemplated. These are of modern gas-fired type, the retorts being arranged in four rows, back-to-back. The air is pre-heated in regenerative chambers under the furnaces; they are protected from injury due to slag from broken pots by the interposition of a layer of chrome-iron ore between the regenerators and the retort chamber. Five gas producers are provided for each pair of furnaces, two being in regular use for each furnace, the fifth being a spare one which can be turned on to either furnace as may be required. Though Delplace furnaces are being installed for roasting, the management is erecting one of special design, upon the results of which future additions will depend. The former are of large type, having 6 muffled hearths each with 18 sections, and should be capable of dealing with 20 tons of raw concentrates per day. Special care has been taken in the design to ensure easy renewals of the hearths as required. [Owing to the uncertainty of the zinc position, the scarcity and high cost of labour, and other reasons, the erection of the Avonmouth works has been delayed.—EDITOR.]

In view of the present high cost of labour and material and the improved extraction now called for, much attention has lately been given to the question of treating retort residues for their metallic contents, both as to still contained zinc, and other metals such as lead and silver, if present. It has been proposed to blow such residues on Wetherill grates, but this yields a mixed product of zinc oxide and lead sulphate and affords only a partial elimination of the silver. Other objections are the inferior quality of the product (due to a certain amount of fine grit being carried over with he fumes), while if silver be present the blown fume acquires a pinkish tint, rendering it unsuitable for paint purposes; further, the silver, both in the fume and the ultimate residues, is lost. In the absence of silver, a market exists for the zinc oxide-lead sulphate product, if free from grit and carrying about 20% of lead; such a mixture makes a paint of covering power superior to pure zinc-white, besides being cheaper. For ores of a less-complex character, blowing the residues offers fair possibilities, and it has even been proposed to modify the usual distilling practice in the direction of only recovering the more easily distilled portion of the zinc, calling for the employment of a smaller amount of reducing coal and leaving a richer zinc residue for blowing. Such a procedure would increase the capacity of the distilling furnace and result in longer life of retorts, as they would not require to be submitted to the high final temperature necessary to drive off the last units of zinc.

Wet processes for zinc extraction with the subsequent recovery of the metal by electrolysis have now become firmly established; Ashcroft's pioneer work in this direction will be remembered. The conditions necessary for success, notably roasting at a low temperature to avoid the formation of insoluble ferrite, and the subsequent perfect purification of the solution are now well understood, the latter condition being demanded by the necessity for keeping the deposited zinc in a passive state to prevent re-solution. As a necessary consequence electrolytic zinc will always be highly pure compared even with the redistilled zinc producible from retorted metal. Much discussion has taken place as to the possibility of the electrolytic process displacing the older method; but it seems probable that for some years to come both processes will survive, and that local conditions with regard to nature of ore, power-cost, and facilities, etc., will determine which method shall be adopted for any particular case. It may be said for the electrolytic process that it certainly permits the utilization of low-grade and complex zinc ores which could never be available to the retort process. As an example, the Canadian Mining & Smelting Co. are treating ores by this method at Trail, which assay as low as 20% zinc and carry 14% of lead. Further, combination dry-and-wet processes are likely to develop wherein the zinc oxide (and lead if present) are concentrated as a fume for subsequent treatment by solution of the zinc followed by electrolysis. Such methods have the advantage of yielding a zinc solution which requires the minimum of purification, while leaving other metallic contents in a form recoverable by smelting.

At Anaconda, Laist has proceeded in a reverse direction, by first extracting roasted flotation concentrates with acid, electrolysing the purified solution, and treating the residues by volatilization in a reverberatory furnace, the contained zinc being recovered as oxide. According to recently published information, Laist no longer recovers the zinc by volatilization, confining this operation to the saving of the lead, while the zinc passes into the slag. How far this is due to more perfect original extraction of the zinc in solution in the previous operation is not stated.

The war brought about a large demand not only for the highly-pure electrolytic zinc of 99·95% grade, but also for metal of 99·9% purity obtainable by the redistillation of ordinary brands, and even of hard spelter which contains about 90 to 92% zinc, the balance being mainly iron. The method chiefly adopted in this country was devised by Fricker, who distils the metal in vertical closed crucibles provided with connecting pipes leading into a brick condensing chamber common to a number of pots, generally eight. The lead and other impurities are prevented from passing over with the zinc vapour by covering the surface of the molten metal with a floating filter of crushed coke, or similar porous material. By this process large quantities of refined metal have been produced for cartridge-brass and other purposes. How far the demand for high-grade zinc will persist for ordinary commercial uses is uncertain. For most alloys containing a substantial percentage of zinc, as also for galvanizing, ordinary brands of spelter are sufficiently pure; hence consumers are not likely to pay the higher price demanded for purity metal. The galvanizer would prefer pure zinc if obtainable at a reasonable price, as a more durable product results from its use. The latter will therefore have to compete with G.O.B., and producers may perhaps be forced to accept a price only greater in proportion to the higher unitage of the purer product.

Before leaving the subject of zinc metallurgy, reference may be made to the manufacture of zinc oxide in this country. Before the war practically the whole of our requirements were met from Continental and American sources. Indeed our secondary products were, in some cases bought by German firms, exported to the Continent for treatment and the zinc oxide produce again sold to us. War conditions have since brought about the establishment of a home zinc-oxide industry; and, as in other cases, we now produce this material of a quality equal in all respects to that hitherto imported. Works capable of producing 50 tons or more per week are running regularly, and, given reasonable protection against unfair competition, there seems no reason why the whole of our requirements should not henceforward be met from home sources. The oxide is manufactured by distillation of hard spelter, scrap, etc., with subsequent burning of the volatilized metal to oxide, which is collected in bag-house plant in the usual way. Technical details as to pipe-arrangements, fan-capacities, etc., have been worked out, and the conditions necessary for the production of the highest quality product have been established. No doubt there will still be competition from American oxide, produced directly from ore, owing to the lower cost of the raw material employed. This oxide, though of inferior colour, is suitable for many purposes such as rubber filling; moreover it possesses the advantage of high density. Oxide production from ores and residues though not yet established in this country is being investigated, and there is reason to anticipate that this may eventually prove successful.

In South Wales zinc-dust (zinc blue) has recently been manufactured direct from metallic scrap and a product obtained which is far superior to that derived as a by-product from the retort process; the latter usually contains about 85% of active zinc while the former carries not less than 95%. The demand of high-grade zinc dust in the dyeing industry is large, while owing to its superior reducing value it should have a good outlet in gold-precipitation. The prepared fume is screened in a flour-miller's bolting machine; owing to its granular character no difficulty is experienced in screening. The product though excessively fine is uniform in size of particle and free from dust; under the microscope each grain is seen as a brilliant metallic sphere. A word may be said as to the perfection of the bolting machine for screening fine powders; this has been developed to meet the stringent requirements of the corn milling industry, and if better known would no doubt find application in screening dry crushed ore.

In the metallurgy of lead recent advances seem to be in detail rather than in fundamental improvements. In the stress of recent years there has been small opportunity of developing new processes in industries that are well established on recognized lines, such efforts being rather devoted to specialties called for by the war. Mention, however, may be made to progress in hydro-metallurgy, as applied to oxidized lead ores. This has been limited to brine treatment with or without the addition of sulphuric acid to carbonate and sulphate ores. This process has been tested in America as well as in North Wales, where a small plant was working until the difficulties of obtaining supplies caused a temporary cessation of operations. In this case the material to be treated consisted of an extensive dump of blende and lead sulphate slimes. Vanner concentration yields a mixed product of no value until further separated. This is effected by agitating the concentrates with hot saturated brine at 70°C., whereby the lead sulphate is completely dissolved, with the equivalent formation of sodium sulphate. The presence of this salt in growing proportions interferes with the solubility of the lead sulphate, and must therefore be removed by the addition of the equivalent amount of calcium chloride. The lead solution is filtered from the blende-calcium sulphate residues, and precipitated with slaked lime, re-forming a portion of calcium chloride; about 50% of the chloride is regenerated, the balance of the chlorine being precipitated with the lead as oxy-chloride. The blende-calcium sulphate residues are then re-treated on a vanner, which effects perfect separation of the easily removed flocculent sulphate, leaving a saleable blende concentrate. The chief objection to the process lies in the chloride present in the lead precipitate involving volatilization loss in smelting, but this may be overcome by precipitating the lead by electrolysis, using soluble iron anodes. This process is limited in its usefulness by the relatively small quantity of material available and by its inapplicability to silver or gold contents. It may, however, develop in the direction of the treatment of low-grade sulphide ores, after a sulphating or chloridizing roast at a temperature low enough to prevent the volatilization.

The Broken Hill Ore-bodies.—In our issue of March, 1915, we illustrated a model of the Broken Hill lodes and ore-bodies made by Mr. O. Trickett, and we quoted a description of the model by Mr. F. Danvers Power. *The Industrial Australian and Mining Standard* for February 27 and March 6 gives some particulars of a new theory relating to these ore-bodies brought forward by the brothers Marshall, together with a statement on the subject by Mr. Danvers Power. The latter says that as far as can be gathered, the Marshalls consider the Broken Hill line of lode to consist, not of one continuous ore-body, but of a number of lenticular ore-bodies, separated from each other, and occupying the troughs of inverted saddles. The lateral pressure which is held to have been responsible for inverting the rocks appears in places to have also been responsible for much overfolding of the leg of the syncline. End pressure has been responsible for pressing the whole channel into a series of crescent-shaped domes and hollows, which have been tilted, giving the synclines a pitch of about one in two. An example of one of these domes is in the Block 14 mine. North from this mine the lenses pitch north. South of Block 14 opposite conditions exist. The Marshalls claim that instead of continuing to pitch north and south, a point must eventually be reached where the folds will come to the surface again, and that the places where they do this is at the old Rising Sun shaft to the south, and at the northern end of the Round Hill to the north, and again in two places between Round Hill and Stephen's Creek.

Mr. E. F. Pittman, when Government Geologist of New South Wales, in a report published in 1893, before the mines were well opened up, wrote: "The principal impression conveyed to my mind is that the Broken Hill ore deposits do not occur in what is known as ordinary true fissure lodes, but should be referred to what are called segregated lodes of the type known in the Bendigo District (Victoria) as saddles." This, of course, referred to the physical form, not to the ore contents. This view caused a good deal of criticism at the time in certain quarters, as the "true fissure veins" were more popular, but later developments have borne out Mr. Pittman's views. One is so accustomed to see cross-sections of lodes which are really domes, that those who are unaccustomed to interpret such sections are apt to look on them as representing open bodies which just tail out or split up like any ordinary fissure. In Nova Scotia such deposits are called "domes," which they are, even if elongated, not "saddles." There is no doubt about the contorted country along the line of the Broken Hill lode, and before the large open-cuts were worked out, the folds and their relation to the lode were exposed to day. Just as lateral folds have their ups and downs, so have end folds; therefore there is nothing unreasonable in expecting the stratum which is pitching underfoot to crop out at the surface again farther on. It is only what one would expect if the force exerted was sufficient, and, if the numerous fractures due to earth movements were brought into communication with mineral solutions, two of the main essentials to an ore deposit would exist.

In the illustrations of the model of the lode already referred to, the general elongated dome-like nature of the lode is to be clearly seen, while a cross-section of Block 10 illustrates the folding of the country, and its relation to what would appear to be the main lode; the latter persistently occupying the position of an attenuated leg of the fold, but continuing past the syncline.

Barite.—In the *South African Journal of Industries* for February Dr. Percy A. Wagner writes on barite (barytes), giving an account of its uses and of its occurrence in South Africa.

Barite has a very wide distribution and is found in a variety of associations. It is a common gangue mineral in lead and zinc deposits, and forms veins in schist, gneiss, and sandstone. It is also frequently found replacing limestone and dolomite. The important barite-pyrite deposits of Meggen in Westphalia are believed by some authorities to be of sedimentary origin. The principal sources of supply in order of importance are the United States, Germany, and England. In Germany and England barite is pre-eminently a vein mineral The bulk of the United States output is, on the other hand, obtained from residual deposits in which the barite occurs as nodules and lumps scattered through clay derived from the weathering of limestone and dolomite.

The main use of barite is in white pigments, in which it is generally mixed with white lead or zinc white, or a combination of both. The basis of lithophone paint, for example, is a mixture of roughly 68% of barium sulphate, 7% of zinc oxide, and 25% of zinc sulphide. It is claimed that the addition of barite makes the pigments more permanent and less liable to be attacked by acids. The mineral is also largely employed for giving weight and finish to certain kinds of paper. Other uses are for coating canvas ham-sacks, for bleaching flannel, for making artificial ivory and pottery glazes, and the manufacture of barium salts. The most important of these salts are the chloride used as a rat poison and insecticide, the peroxide used in the preparation of hydrogen peroxide and oxygen, the precipitated sulphate or blanc fixe, used in the rubber, paint, and paper trades, the nitrate used in the chemical and explosives trades, and the carbonate used in the manufacture of glass and ceramic ware. Barite is also used for adulterating flour, and in sulphuric acid works for jointing and acid-proof packing.

To suit the requirements of the paint trade, which absorbs most of the barite mined, the mineral has to be very finely ground and of pure white colour. The grinding is generally accomplished in buhr-mills arranged in series, as many as eleven sets of stones being employed in some plants. After passing the last mill the powder is bolted through cloth and packed in bags or barrels. In order to obtain a particularly fine product of uniform grade, grinding by buhr-stones is in some American plants supplemented by water flotation. As a preliminary to fine grinding, most varieties of barite have to be bleached in order to secure the necessary degree of whiteness. This is done by treating the crude ore, crushed to a size dependent on the form in which the impurities are present, with hot dilute sulphuric acid in large lead-lined wooden or steel vats, the heating and agitation being effected by blowing steam through the sludge. In some plants, however, mechanical stirrers are employed.

Barite comes on to the market in its crude state and in a pulverized and bleached condition. It is valued according to colour and purity, and in the case of the ground product on its degree of fineness. For the paint trades colour counts for more than purity, the various grades being arranged on that basis. The two most objectionable impurities in barite intended for the paint trade are lime and iron; the former on account of its disintegrating action in a paint whose other constituents may have acid properties, the latter because of its influence on the whiteness of the pigment. Gypsum, which is sometimes associated with barite, is less objectionable, as it can be readily separated from that mineral by virtue of its low specific gravity.

While barite appears to be widely distributed in South Africa, very little information is available in regard to the individual occurrences of the mineral. The most important of these are situated in Southern Rhodesia. A large deposit near Hunter's Road has now for some time past supplied the requirements of the Sienna Paint Company at Durban, and of two of the large explosives works in the Union. Another very important deposit has recently been discovered near Bulawayo. In the Union a promising occurrence was opened up some time ago near Riversdale, Cape Province, by J. H. MacArthur. The barite is of pale bluish-white colour and averages 87% of $BaSO_4$. Small quantities are being supplied to Colours, Limited, of Capetown, who use it in the manufacture of white paint. In the Transvaal massive barite of pure white colour is said to be available in large quantity on the farm Vergelegen No. 1695, on the Magalaquen River, 80 miles north-west of Pietersburg. The mineral also occurs on the farm Enkeldoorn No. 373, in the bushveld to the north-east of Pretoria. In the north-eastern corner of the Pretoria District a series of quartz-barite veins are found intersecting felsite, belonging to the Bushveld Complex, on the farms Tweefontein No. 268 and Bloedfontein No. 515. The veins are up to 2½ ft. in width. In its typical development the vein matter consists of tabular crystals of white or pinkish white barite in a matrix of white quartz, in which small drusy cavities lined with quartz crystals are fairly common. The distribution of the barite is irregular, the mineral being altogether absent from some sections of the veins and abundant in others. The veins are of no economic importance. According to J. Ryan, a system of barite veins crosses the Transvaal-Swaziland border near Steynsdorp, and a number of veins carrying barite are exposed along the footpath from Pigg's Peak to Barberton, about a mile north-east of Height's Store. Isolated crystals of barite are found in the blue ground and yellow ground of the Kimberley diamond mines, and also in tuffs and breccias occupying the volcanic necks in the neighbourhood of Sutherland, Cape Province.

The principal consumers of barite in the Union are the explosives factories and paint manufacturers. Of the former, the Cape Explosives Works at Somerset West use about 1,700 pounds per month, Kynoch's, at Umbogintwini, about 5 tons per annum, and the British South African Explosives Company, at Modderfontein, from 10 to 15 tons per annum. In regard to the requirements of the Sienna Paint Company, of Durban, and Colours, Limited, of Capetown, no data are available. A small quantity of barite is also used by the South African Rubber Manufacturing and Tyre Company, Johannesburg. It is doubtful whether the total South African requirements amount to 5 tons per month, and, as there is no prospect of establishing an export trade in the mineral, there is little likelihood of the local barite industry attaining to important dimensions.

Frasch Sulphur-Mining Patents.—News is to hand that the United States Circuit Court of Appeals sitting at Philadelphia has decided that the Frasch patent for the application of the air-lift to the raising of sulphur from deep-seated deposits after being first rendered molten by the application of hot water pumped downward cannot be upheld on the point of novelty. It will be remembered that the sulphur deposits of Louisiana and Texas are found at considerable depth in association with salt and petroleum. All attempts at mining these deposits failed, until Herman Frasch, the chemist of the Standard Oil Company who had previously invented the successful method of removing sulphur from petroleum, solved the problem by the method indicated above. We gave an outline of Frasch's work in our issue of March, 1912, in reporting the proceedings at the presentation to him of the Perkin medal The process, however, requires description on this occasion, in order that the recent lawsuit shall be understood. We extract this information from an article published in the *Engineering and Mining Journal* for March 29.

Patents were issued to Frasch in 1891, according to which a well is bored from the surface to the sulphur deposit, "as usual in making salt and oil wells." In this well a casing is inserted, for which a diameter of 10 in. is suggested. Within the 10 in. casing, concentric pipe, for which a diameter of 5 in. is suggested, reaches to the bottom of the well. The patents state that the 10 in. pipe may be stopped at the caprock or be extended down into the mine, and that the 5 in. pipe may be provided with perforations at the side, or otherwise be "provided with a strainer." The patents further describe the heating of the water and forcing it into the mine at a suitable temperature sufficiently above the melting point of sulphur to be effective when it reaches the sulphur deposit, and, accordingly, to melt the sulphur and reduce it to a fluid. Both the 10 in. pipe and the 5 in. pipe are described as connected with the heater, so that the hot water may pass down through either of them. The hot water might be forced down the outer pipe under such pressure as to force the melted sulphur up the inner pipe to the surface, or "the liquefied sulphur need not be forced up by the heat-conveying liquid, but might be pumped up in any ordinary or suitable way."

The Frasch patents, after running their full course of 17 years, expired in 1908. The process and apparatus which they covered then became public property under the provisions of the patent law. There are, in fact, only two fundamental requirements for the mining of sulphur by hot-water fusion. One is to pump down into the deposit an adequate volume of hot water at a sufficient temperature to melt the sulphur and to keep it melted. Another is to raise the sulphur out of the well by what Frasch calls "a pump or pumps" or "other fluid-moving means," including "any known or suitable substitute for a pump." With the apparatus which is provided in these expired patents, hot water can be pumped down into the deposit in ample volume and at the requisite temperature, and when the sulphur is thus reduced to liquidity, it can be pumped out.

Instead of the sucker-rod pump an ordinary air lift was subsequently used. It was a second-hand air lift, bought for the purpose, and when inserted in place of the sucker-rod and its various adjuncts, it operated, as might have been expected, without a hitch. Whether the sucker-rod pump was used or the air lift, the mode of operation was necessarily the same, in that in both cases the hot water forced into the sulphur deposit melted the sulphur, and the pumping devices (that is, the sucker rod pump or the air lift, both of which were common expedients for raising liquids from great depths in the mining industry) raised the liquid sulphur to the surface.

Almost at the end of the term of the expired Frasch patents, the Patent Office nevertheless issued additional patents to Frasch, assuming to give him a monopoly of the use of an air lift as the means of raising the melted sulphur from the deposit. The appeal, to which reference is made above, in the case of the Union Sulphur Co. *versus* the Freeport Texas Co., has resulted in a decision which insists that the patent in question lacks the essentials of an invention, owing of course to the fact that the use of the air lift formed part of the original patents and the right to its use therefore expired with the original patents. The use of an air lift, therefore, involves no infringement.

SHORT NOTICES

Electric Winding. The *Iron & Coal Trades Review* for May 16 describes a Westinghouse electric winding plant erected at the Kilton Collieries.

Preservation of Timber.—At the May meeting of the Manchester Geological & Mining Society, Noah T. Williams read a paper on the preservation of mine timber.

Drill Steel.—The March *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by H. A. Read on economies in hand drill steel.

Cementation.—The *Journal* of the South African Institution of Engineers for April contains a continuation of the discussion on the relative advantages of rectangular and circular shafts. In particular we note a contribution by Thomas Blandford on the cost of the cementation process as applied to stop the water-flows in Daggafontein and Brakpan shafts.

Corrosion of Wire Ropes.—In the *Mining and Scientific Press* for May 3, W. Fleet Robertson writes on the internal corrosion of cables, recounting the results of investigations relating to the accident at a colliery at Nanaimo, British Columbia, owing to the breakage of a hoisting rope.

Copper Slags.—In the *Engineering and Mining Journal* for May 10, C. G. Maier and G. D. Van Arsdale describe microsopical and chemical investigations as to the condition in which copper is contained in blast-furnace slags. The experiments, in which slags produced by the Phelps Dodge Corporation were employed, indicate that copper exists in two physical forms, chemically similar: (1) as dissolved copper sulphide, in blast-furnace and reverberatory slags usually about 0·15% Cu, in converter or mixed slags up to 0·5% Cu; (2) mechanically suspended particles of sulphide copper varying in composition from matte to $Cu_2S + x\ Cu$ and in amount equal to total copper less dissolved copper. The probable main cause of the retention of mechanically suspended particles, apart from inefficient settling and viscosity, is the attachment of gas bubbles, which probably is due to the action of ferric iron in the slag on iron sulphide in the matte. The dissolved copper sulphide content acts like a saturated solution with respect to fusion with such addition agents as pyrite, iron sulphide, and calcium sulphide.

Refining of Gold and Silver.—The *Engineering and Mining Journal* for May 3 reprints a paper by G. G. Griswold, read before the American Electrochemical Society, describing the Moebius process for electrolytically refining silver bullion and the Wohlwill method for refining gold and recovering platinum and palladium, as practiced at the works of the American Smelting & Refining Co., at Maurer, New Jersey.

Copper Assay.—In *Chemical and Metallurgical Engineering* for May 1, R. G. Place describes the rapid electrolytic assay for copper without the cathode being rotated.

Vanadium.—In *Chemical and Metallurgical Engineering* for May 1, J. E. Conley describes the extraction of vanadium from cuprodescloizite, which is found fairly plentifully in the Shattuck-Arizona copper mine.

United States Manganese Deposits. — The May *Bulletin* of the American Institute of Mining and Metallurgical Engineers contains an abstract of a lengthy paper by E. C. Harder and D. F. Hewett entitled: "Recent Studies of United States Manganese Deposits." The paper is only sent on application by those interested.

Manganese in Queensland. — The *Queensland Government Mining Journal* for February contains a paper by Dr. H. I. Jensen describing manganese ore deposits in the Cairns district.

Magnesite and Chromite in Queensland.—In the *Queensland Government Mining Journal* for February, E. C. Saint-Smith describes magnesite deposits at Mount Pring, near Bowen. Associated with the deposit are veins containing chromite.

Chrome Ore in Maryland.—*Economic Geology* for May contains a paper by J. T. Singewald on chromite-bearing sands found in Maryland, and the method of washing the sands for the recovery of chromite.

Porcupine.—In the *Mining and Scientific Press* for April 19, Ellsworth Y. Dougherty discusses the gold-quartz lodes at Porcupine, Ontario.

Quicksilver in Oregon.—In the *Engineering and Mining Journal* for May 3, A. E. Kellogg describes the Chisholm mercury mine in Jackson County, Oregon.

Geology of Palestine.—At the meeting of the Geological Society held on May 7, Major R. W. Brock, formerly director of the Geological Survey of Canada, delivered a lecture on the geology of Palestine, where he did much work for the War Office during the past three years.

Shasta County, Cal.—In the *Mining and Scientific Press* for April 26, Herbert Lang writes on mining and metallurgy in Shasta County, California. Of interest to English readers is his account of the mines of the Mountain Copper Company.

Asbestos in the Transvaal.—The *Transactions* of the Geological Society of South Africa for 1918 contains a paper by A. L. Hall on the mode of occurrence of asbestos in the Transvaal.

Brazilian Diamonds.—*Economic Geology* for May contains a paper by R. Crandall, geologist to the Brazilian Geological Survey, describing the geology of the Bahia diamond district, Brazil.

Mozambique.—The *Quarterly Journal* of the Geological Society, May 6, 1919, contains Dr. Arthur Holmes's paper on the Pre-Cambrian and associated rocks of Mozambique, which was read on June 20, 1917.

Oxidation of Ammonia.—*Chemical and Metallurgical Engineering* for May 1 reprints a paper by W. S. Landis, read before the American Electrochemical Society, on the production of nitric acid by the oxidation of ammonia.

Petroleum Problems.—At the May meeting of the Institution of Petroleum Technologists, Dr. F. Mollwo Perkin and T. C. Palmer read a paper entitled: "The Chemist and Engineer in relation to the Petroleum Industry."

The German Metal "Octopus."—The *Mining and Scientific Press* for April 26 commences a reprint of the report of the United States Alien Property Custodian on the ramifications throughout the world of the German metal-buying organization, colloquially known as the "Octopus," established by the Metallgesellschaft, in association with Aron Hirsch und Sohn, and Beer, Sondheimer & Co.

RECENT PATENTS PUBLISHED.

7,562 of 1916 (125,119). H. W. C. ANNABLE and NICKEL CONCENTRATION LTD., London. Converting the nickel silicate of garnierite into nickel sulphide by heating with moist sulphuretted hydrogen.

13,853 of 1916 (125,642). B. MOHR and C. HEBERLEIN, London. In the treatment of copper-nickel matte, roasting the matte to oxide, reducing to metal in an atmosphere of water gas, dissolving the nickel by sulphuric acid, and casting the residue containing copper and precious metals into anodes to be refined electrolytically.

1,495 of 1918 (125,681). S. F. BARCLAY, Sheffield. In the electrostatic precipitation of dust from gases, the employment of a wet surface.

6,066 of 1918 (118,086). G. B. GALLINI, Lovere, Italy. A crushing machine consisting of a drum revolving on a horizontal axis and containing a series of swinging hammers.

6,351 of 1918 (126,108). W. E. NETTLE, P. SELBY, J. BLYTH, and J. H. HOLMAN, Johannesburg. A device for feeding water through the steels of piston rock-drills, having for its object the prevention of the water entering the air-cylinder.

7,059 of 1918 (126,114). H. W. HARDINGE, New York. Improvements in conical grinding mills having for their object the prevention of discharge of particles not sufficiently ground. A screen is fixed about half-way along the cone on the discharge side of the mill, and means are employed, either by perforations in the cone, by vanes, or by suction, to remove the particles passing the screen as soon as possible, thereby preventing clogging of the screen

7,311 of 1918 (125,785). E. G. BURR, Montreal. Improvements in the method of producing alloys by introducing volatile metal or other substance into molten metal.

7,665 of 1918 (115,846). G. H. CLEVENGER, Palo Alto, California. Method of removing cobalt from zinc sulphate solutions before electrodeposition of the zinc.

8,201 of 1918 (125,265). A. C. BASEBE and R. E. SMART, London. An electrically operated stamp for crushing metal and other substances.

9,283 of 1918 (124,960). C. W. BAILEY, H. S. DENNY, and A. T. JEFFERIS, Langwith, Mansfield. Method of extracting potassium nitrate from Chile nitrate

9,297 of 1918 (126,192). CARBORUNDUM CO., Niagara Falls, New York. A refractory material consisting of natural flake graphite, silicon carbide, and a binding material.

10,478 of 1918 (124,977). E. E. & P. C. DUTT, Jubbulpore, India. Method of extracting pure manganese dioxide from manganese ores by heating with caustic soda, and treating the manganate thus formed with steam.

10,553 of 1918 (124,978). J. WILKES and H E. HARRIS, Stockton-on-Tees. Improved reverberatory furnace for recovering zinc from dross.

12,219 of 1918 (120,549). E. S. BERGLUND, Trollhättan, Sweden. For the purpose of making zinc powder consolidate into the liquid zinc in the condenser, building a continuous screw in the bottom so as to rub the powder and remove the oxide or other coating that prevents the particles dissolving in the molten material.

14,614 of 1918 (125,310). FANSTEEL PRODUCTS CO., Chicago. Improvements in the method of reducing tungstic acid to tungsten by means of hydrogen.

15,199 of 1918 (125,876). A. BOOTH, Leeds. Improvements in jaw-breakers employed for fine crushing.

15,389 of 1918 (125,879). A. W. GREGORY, London. Method of precipitating pure white tin oxide from sulphostannate solutions produced in removing tin from scrap by alkali and sulphur.

15,856 of 1918 (125,012). R. C. NEWHOUSE, Wauwatosa, Wisconsin. Combined cylindrical ball and tube mill with separating screen between the two sections.

21,529 of 1918 (125,344). J. M. DRAPER, Bridgend, Glamorgan. Improvements in coal washers.

113 of 1919 (125,046). GENERAL ELECTRIC CO., Schenectady, New York. Obtaining an unoxidizable surface for copper or iron by heating with aluminium powder.

388 of 1919 (122,195). ELEKTRIZITATSWERK LONZA, Bale, Switzerland. Making mercuric oxide by oxidizing mercury by gases containing oxygen with the help of dry oxides of nitrogen as oxygen carrier.

NEW BOOKS

☛ Copies of the books, etc., mentioned below can be obtained through the Technical Bookshop of *The Mining Magazine*, 723, Salisbury House, London Wall, E.C 2.

Aids in Practical Geology. By Grenville A. J. Cole, F.R.S., Seventh Edition, revised. Cloth, octavo, 450 pages, illustrated. Price 10s. 6d. net. London: Charles Griffin & Co., Ltd.

This well-known work, which has thoroughly justified its title for nearly thirty years, and which has deservedly earned for its author the gratitude of a long stream of students, now enters on a renewed course of popularity by the issue of a seventh and revised edition. Professor Cole is singularly gifted with the capacity all too rare of writing in a manner at once learned and attractive; and his style, a happy reflection of his own personality, combines lucidity and accuracy with a charm of treatment which stimulates enthusiasm.

These attributes are not naturally associated in most works of reference, but here we have a volume in which only certain chapters come into that category, while others clothe what may be thought the dry bones of the subject with an animating spirit by which their relations to the more fascinating and interpretive aspect of geology is revealed.

Science may be regarded in part as a systematic method of investigating problems, and Professor Cole's book gives the data and methods whereby the problems suggested in the field or by the materials collected, may be tackled at home or in the laboratory. The first part deals with field observations and the collection of the representative specimens Succeeding parts are concerned in turn with the examination of minerals, rocks, and fossils. The simpler petrographic methods are briefly but effectively described, and the treatment of blowpipe analysis is fortified by a valuable chapter on the quantitative determination of felspars by their flame reactions. This method, originally introduced by Szabo, represents the first step in a development of blowpipe analysis which has been too long delayed, namely, the rapid recognition by a single test of two or more elements in combination or association. The absence or paucity of data referring to interferent reactions in all published accounts of blowpipe analysis has led to a serious but unnecessary limitation of the subject, and it is to be hoped that a really satisfactory treatment may soon be forthcoming on the lines followed by Professor Cole in connection with the felspathic minerals.

A useful account of the optical properties of minerals is followed by an alphabetical summary of the rock-forming minerals under each of which the most striking megascopic and microscopic characters are respectively set forth. This leads up to the study of rocks, which is dealt with broadly from the genetic standpoint, and in a more detailed manner from the determinative standpoint. Professor Cole rightly deprecates the introduction into petrography of an abundance of new names, and his account of the igneous rocks is characterized by simplicity and a well-balanced sense of proportion. It is necessarily open to criticism, as any treatment of that unsettled subject must be, and especially one in which simplicity is sought. Nevertheless as the classification followed is free from the pernicious usage of terms like "acid" and "basic," which elsewhere have been extended far beyond their legitimate scope, and as it is free from any purely theoretical or subjective assumptions, this section is notably praiseworthy and may safely be followed with confidence. The only suggestions the reviewer would offer are, that a more clean-cut distinction between the diorites and gabbros and their respective aphanitic equivalents might be introduced, and that a systematic account—as yet not attempted in any text-book—of the late magmatic alterations of igneous rocks might usefully be added.

The fourth part of the book dealing with fossils, is still the most satisfactory short account of the complex and often forbidding subject of invertebrate paleontology. The descriptions are clear, the illustrations good, and the nomenclature unburdened by the niceties of the expert, who is often the creator of a maze of terms which may be of zoological significance, but which are far from being aids in practical geology. Thus, as throughout, the book is well proportioned, and well illustrated; while an additional feature worthy of mention, as it is too rarely seen, is the inclusion of the leading references to the topics under discussion. Whether for a student in the laboratory, or an explorer or prospector in the field, no other single book can be so thoroughly recommended for the purpose specified in its title, as this. ARTHUR HOLMES.

Manganese and Chromium in California. By W. W. Bradley, E. Huguenin, C. A. Logan, W. B. Tucker, and C. A. Waring. Bulletin No. 76 of the California State Mining Bureau.

Mineral Deposits of South America. By Benjamin L. Miller and Joseph T. Singewald, Jr. Cloth, octavo, 610 pages, illustrated. Price 25s. New York: McGraw-Hill Book Co.; London: Hill Publishing Co., Ltd.

The Efficient Purchase and Utilization of Mine Supplies. By H. N. Stronck and J. R. Billyard Cloth, octavo, 100 pages. Price 6s. net. New York: John Wiley & Sons; London: Chapman & Hall.

Gold, Prices, and the Witwatersrand. By R. A. Lehfeldt. Cloth, small octavo, 130 pages. Price 5s. net. London: P. S. King & Son. This is No. 54 in a series of monographs by writers connected with the London School of Economics and Political Science.

Bibliography of Indian Geology. By T. H. D. La Touche. Part I, 599 pages; Part II, 492 pages. Price 8 rupees. Calcutta: The Geological Survey of India. The first part gives a bibliography relating to Indian geology and physical geography, and the second consists of an annotated index of Indian minerals of economic value.

Geology of the Country round Belfast. By A. L. Hall, with an introduction by Dr. A. W. Rogers. This is a publication of the Geological Survey of the Union of South Africa, and consists of Sheet 16 of the Survey together with a pamphlet explanatory of the geology. No mineral deposit of first-class importance is included in this area. Three small gold deposits are known, asbestos has been worked, and coal occurs at several places.

COMPANY REPORTS

Lena Goldfields.—This company was formed in London in 1908 by F. W. Baker and the Consolidated Goldfields of South Africa to acquire a majority of the shares in the Lenskoie, a Russian company working gold placers in east Siberia. Three years ago it was announced that G. Benenson and associates in Russia were purchasing a controlling block of 51,000 Lenskoie shares from the English company, but political conditions have made it impossible for Mr. Benenson to complete the purchase, about 23,000 having been paid for so far. The reports for the years ended September 30, 1917, and September 30, 1918. are now issued. From these it appears that the Lenskoie company has doubled its capital by the issue of 110,000 additional shares of 150 roubles each. As regards the mines, three of these are being worked by drifting, namely, the Feodosievsky, the Chanchik, and the Svetly. The dredge, ordered some time ago, is not expected to be in operation until 1922. The report by C. W. Purington, the consulting engineer, covers the period up to November, 1917, since which time no returns were recieved at his office. He estimated the drifting reserves at 711,200 cu. yd., averaging 39s. 10d. per yard, and the dredging reserves at 59 million yards averaging 1s. 7½d. per yard.

Modderfontein B.—This company was formed in 1908 by the Central Mining-Rand Mines group to develop property in the Far East Rand adjoining the New Modderfontein on the east. Milling started in 1911. The report for 1918 shows that, after the rejection of 15% waste, 605,900 tons averaging 10·27 dwt. gold per ton was sent to the mill. The yield of gold by amalgamation was 178,220 oz., and by cyanide 123,058 oz., making a total of 301,278 oz., worth £1,254,053, or 41s. 5d. per ton milled. The working cost was £595,466, or 19s. 8d. per ton, leaving a working profit of £658,586 or 21s. 9d. per ton. The amount spent on capital account was £52,833. The shareholders received £577,500, being at the rate of 82½%. As compared with the previous year, the ore treated was 88,000 tons more, the yield per ton 4s. 9d. less, and the working cost per ton 3d. higher, while the dividend compared with 85%. The reason why the yield per ton was lower was that the full amount of rich ore from the south-west portions of the workings could not be raised. Scarcity of labour interfered with developments, and the reserve stands at 3,378,000 tons averaging 9·2 dwt., as compared with 3,523,810 tons of the same tenor the year before. An arrangement has been made with the Geduld whereby ground near the latter's border is being tested. Driving has already been extended 225 ft into Modder B ground, along which the ore has been proved to average 20 dwt. over 58 inches. A new circular shaft is to be sunk for the purpose of dealing with the south-eastern part of the property. The additional treatment plant, to which reference was made a year ago, has been completed, and the capacity is now 60,000 tons per month.

Modderfontein Deep.—This company belongs to the Union Corporation (Goerz) group, and was formed in 1899 to acquire a gold-mining property in the Far East Rand, to the south of New Modderfontein. Shaft-sinking was started in 1910, and milling at the end of 1914. The report for 1918 shows that 534,275 tons was raised, and after the removal of waste, 505,950 tons averaging 9·94 dwt. per ton was sent to the mill The output by amalgamation was 144,560 oz., and by cyanide 99,110 oz., making a total of 243,670 oz., worth £1,035,472, being a yield of 40s. 11d. per ton milled. The working cost was £441,621, or 17s. 5d. per ton, leaving a working profit of £593,851, or 23s. 6d. per ton. The dividends absorbed £487,500, being at the rate of 97½%. The ore reserve is estimated at 3,450,000 tons averaging 8·8 dwt. per ton, as compared with 3,320,000 tons averaging 8·7 dwt. the year before.

Government Gold Mining Areas (Modderfontein).—This company was formed by the Barnato group (Johannesburg Consolidated) in 1910 to acquire a Government mining lease in the Far East Rand, being the first company formed to acquire a lease on the profit-sharing basis. Milling commenced in October, 1914, with 100 stamps and 10 tube-mills, and this plant was duplicated at the end of 1916. At first the ore disclosed was of lower grade than that at other mines in the Far East Rand, but during the last year or two the results of development have shown a marked improvement. The report for 1918 shows that 1,452,995 tons was sent to the sorting stations, and that after the removal of 10% waste, 1,303,500 tons averaging 8·14 dwt. gold per ton was sent to the mill. The yield by amalgamation was 283,176 oz., and by cyaniding 225,256 oz., making a total of 508,422 oz., worth £2,162,584, being a yield of 33s. 2d. per ton milled. The working cost was £1,286,258 or 19s. 9d. per ton, leaving a working profit of £876,326, or 13s. 5d. per ton. The Government's share of the profits was £369,982, and the shareholders received £385,000, being at the rate of 27½%. The mine has developed excellently during the year, and the reserve stands at 9,445,000 tons averaging 8 dwt., as compared with 7,016,000 tons averaging 7·5 dwt. the year before. During the year five additional tube-mills have been erected and the Butters filter-press installation has been enlarged.

Van Ryn Deep.—This company belongs to the Barnato group, and was formed in 1902 as an amalgamation of a company of the same name with the Kleinfontein Deep, in the Far East Rand. Milling was started in the middle of 1913, and the first dividend was paid early in the next year. The report for 1918 shows that 673,213 tons of ore was raised, and after the rejection of 21% waste, 530,550 tons averaging 10·48 dwt. per ton was sent to the mill. The yield of gold by amalgamation was 181,231 oz., and by cyanide 91,957 oz., making a total of 273,189 oz., worth £1,163,005, being a yield of 43s. 10d. per ton milled. The working cost was £545,921, or 20s. 7d. per ton, leaving a working profit of £617,084, or 23s. 3d. per ton. The shareholders received £538,601, being at the rate of 45%, and £88,042 was paid as taxes. The additional metallurgical plant bringing the yearly capacity to 648,000 tons was completed about the middle of the year, but labour shortage prevented any increase in the amount of ore mined, so that advantage cannot yet be taken of the increased capacity. The ore reserve is estimated at 2,445,759 tons averaging 9 dwt., as compared with 2,258,598 tons averaging 8·9 dwt. the year before. The central and eastern sections continue to develop satisfactorily. Owing to labour shortage it has not been possible to explore on the western side.

Geduld.—This company belongs to the Union Corporation (formerly Goerz) group, and was formed in 1899 to acquire gold-mining rights in the Far East Rand. Development was started in 1904, and milling in 1908. Water troubles made it necessary to stop mining for a time, and operations were not resumed until 1910. The capacity of the plant was extended in 1913 and 1917. The report for 1918 shows that 524,617 tons was raised, and after the removal of waste, 513,100 tons averaging 7·44 dwt. per ton was sent to the mill. The yield of gold by amalgamation was 71,452 oz., and by cyanide 104,731 oz., making a total of 176,183 oz., worth £747,905, being a yield of 29s. 1d. per ton milled. The working cost was £513,664, or 20s. per ton, leaving a working profit of £234,241, or 9s. 1d. per ton. The expenditure on capital account was £83,307, and the shareholders received £109,125, being at the rate of 11¼%. The amount of ore treated was 87,650 tons more than in 1917, and 190,220 tons more than in 1916, but the profit per ton was 10d. less. The working profit was £21,404 higher and the dividend compared with 10% the year before. The ore reserve is estimated at 2,510,000 tons averaging 7·5 dwt., an increase of 310,000 tons during the year.

New Kleinfontein.—This company belongs to the Anglo-French Exploration group, and was formed in 1893 to acquire an outcrop property in the Far East Rand to the south-west of the Van Ryn. In 1914 the Benoni and Apex properties were absorbed, and a new treatment plant was erected at the Apex, where milling was commenced in the middle of 1916. The report for 1918 shows that 821,081 tons of ore was raised, of which 528,812 tons came from the Kleinfontein section, 131,504 tons from the Benoni, and 90,765 tons from the Apex. The amount of waste removed was 146,460 tons. The Kleinfontein plant treated 457,550 tons and the Apex plant 217,190 tons. The total yield of gold was 205,951 oz., worth £860,265, being a yield of 25s. 5d. per ton milled. The working cost was £810,456, or 24s. per ton, leaving a working profit of £49,828, or 1s. 5d. per ton. Toward the end of the year the milling policy was altered; the Apex plant was worked up to its capacity, and the Kleinfontein plant handled the remainder of the ore, the average number of stamps running at the latter being 110 out of 200. In this way a slight reduction in cost and a higher recovery were obtained. The total ore milled was 130,000 tons less than in 1918 owing to floods and shortness of labour. The ore reserve is calculated at 2,048,000 tons averaging 5·78 dwt., as compared with 2,214,000 tons averaging 5·46 dwt. at the end of 1917.

Witwatersrand Gold.—This company was formed in 1886 to acquire Knight's property in the eastern Rand. Control passed to the Barnato group shortly before the Boer War. In the early days the results were not good, but for a dozen years from 1905 onward excellent dividends were paid. The report for 1918 shows that labour shortage has caused a fall in the output, and that the mining of a larger amount of reclamation ore has reduced the average yield. The amount of ore raised was 474,671 tons, and after the rejection of waste, 428,550 tons averaging 5·76 dwt. was sent to the mill. The yield of gold by amalgamation was 89,935 oz. and by cyanide 26,341 oz., making a total of 116,276 oz., worth £496,674, being a yield of 23s. 2d per ton milled. The working cost was £412,793 or 19s. 3d. per ton, leaving a working profit of £83,881 or 3s. 11d. per ton. The shareholders received £70,443, being at the rate of 15%. The reserve is estimated at 1,390,000 tons averaging 6 dwt., as compared with 1,317,900 tons averaging 6·4 dwt. a year ago.

Crown Mines.—This company, formed in 1892 as the Rand Deep Level Gold Mining Co., was expanded in 1909 on the amalgamation of the Crown Deep, Crown Reef, Robinson Central Deep, Langlaagte Deep, and other properties in the central Rand. The control is with Rand Mines, Limited. The company has not fulfilled expectations as regards cheap working on a large scale, and moreover the yield has been lower than originally expected. The report for 1918 shows that 2,054,451 tons was raised, and after the removal of waste, 1,861,000 tons averaging 6·77 dwt. gold per ton was sent to the mill. The yield by amalgamation was 443,467 oz., and by cyanide 163,158 oz., making a total of 606,625 oz., worth £2,528,759, or 27s. 2d. per ton milled. The working cost was £2,118,117, or 22s. 9d. per ton, leaving a working profit of £410,642, or 4s. 5d. per ton. Out of the profit £65,587 was spent on shaft sinking and equipment, £83,600 was devoted to the redemption of debentures, and £59,677 was paid to the Government. The shareholders received £188,021, being at the rate of 20%, comparing with 140% for the year the amalgamation was effected. The ore reserve is calculated at 5,019,750 tons averaging 6·9 dwt. in the Main Reef Leader, and 3,278,350 tons averaging 5·6 dwt. in the South Reef. Of the total, 1,194,800 tons averaging 7·5 dwt. is not at present available for mining, consisting of shaft and safety pillars. The total was 689,900 tons less than the year before, but the content is 0·1 dwt. higher. The better quality ore, in the Robinson Central Deep section at the east end of the property, is nearly exhausted, and the average grade sent to the mill will be reduced in consequence, though by means of selective mining this tendency will be counteracted as much as possible. A great deal of active development in the ground between the 16th and 19th levels is now being done, and three shafts to serve the ground further down on the dip are being sunk. Developments on the South Reef have been poor, and there are signs that this reef will be unworkable in depth.

City Deep.—This company belongs to the Central Mining—Rand Mines group, and was formed in 1899 to acquire deep-level property in the central Rand on the dip of the City & Suburban, Meyer & Charlton, Wolhuter, and Goch mines. Milling commenced in 1910. For one reason and another, the amount of ore raised has never been up to the capacity of the treatment plant. This position is once more brought into prominence by the fact that the output of ore and gold for 1918 is lower than that for 1917, the reasons being the serious shortage of labour during the influenza epidemic and falls of ground in the richest parts of the mine. The amount of ore raised was 742,383 tons, and after the removal of 10% waste, 670,100 tons averaging 9·3 dwt. per ton was sent to the mill. The yield of gold by amalgamation was 223,299 oz. and by cyanide 82,876 tons, making a total of 306,175 oz., worth £1,274,881, or 38s per ton milled. The working cost was £827,587, or 24s. 8d. per ton, leaving a working profit of £447,293, or 13s. 4d. per ton. Out of the profit, £343,750 was distributed as dividend, being at the rate of 27½%. As compared with the previous year, the tonnage milled was 74,000 tons less, the yield per ton 1s. 6d. less, the working cost per ton 3s. 1d. higher, the total profit £220,959 less, and the dividend £218,750 less. The ore reserve is estimated at 3,342,700 tons averaging 9·6 dwt., as compared with 3,326,900 tons averaging 9 dwt. the year before. The north-western section of the mine under the Meyer & Charlton continues to develop rich ore, but easterly the development gives varying results.

Village Deep.—This company belongs to the Central Mining—Rand Mines group, and was formed in 1898 to acquire deep-level ground below the Village Main Reef, which itself was a deep level below the Wemmer, Salisbury, and Jubilee, in the central Rand. The report for 1918 shows that labour shortage and water troubles had an adverse influence on the output, while the yield per ton was lower and the cost higher. The ore raised was 663,671 tons, and after the removal of 11% waste, 565,300 tons averaging just over 7 dwt. gold per ton was sent to the mill. The yield of gold by amalgamation was 131,244 oz., and by cyanide 59,245 oz., making a total of 190,469 oz., worth £792,518, being a yield of 28s. 2d. per ton. The working cost was £726,262, or 25s. 10d. per ton, leaving a working profit of £66,256, or 2s. 4d. per ton. The expenditure on capital account was £22,300. The shareholders received £39,775, being at the rate of 3¾%. The dividend for 1917 was £172,359, and the rate 16¼%. The developments during the year have disclosed ore of lower grade than formerly, the amount being 840,740 tons averaging 6·3 dwt. The reserve is estimated at 2,327,200 averaging 6·3 dwt., as compared with 1,847,000 tons averaging 6·6 dwt. the year before. Rights to mine under Springfield Extension and a portion of La Rochelle have been obtained from the Government and ore below the former has been added to the reserve.

Meyer & Charlton.—The mine worked by this company is the most important producer in the Albu group, and contains some very rich ore. The company was formed in 1888 to work an outcrop property in the Central Rand, and in 1909 an additional block on the dip was purchased. The report for 1918 shows that 137,736 tons was sent to the stamps, and that the total output of gold was 109,354 oz., being a yield of 15·9 dwt. per ton. The value was £456,555, or 66s. 3d. per ton, and the working cost was £181,474, or 26s. 4d. per ton, leaving a working profit of £275,080, or 39s. 11d. per ton. The shareholders received £220,000, being at the rate of 100%. The reserve is estimated at 504,496 tons averaging 15·84 dwt., of which 441,234 tons averaging 17·18 dwt. over 52 in. is in the Main Reef Leader. A year ago the reserve in the Leader was 312,996 tons averaging 20·5 dwt. The rise in the tonnage and the fall in the grade are explained by the fact that the stoping width is greater than was previously assumed.

Consolidated Langlaagte.—This company belongs to the Barnato group, and was formed in 1902 to amalgamate the Crœsus and Langlaagte Star, in the western part of the central Rand. The Crown Reef-Ferreira dyke upthrows the reefs, bringing the southern portions 1,100 ft. nearer the surface, so that a new scheme of development of this part of the property had to be adopted, involving the sinking of two new shafts. The mill was rebuilt in 1912 with modern heavy stamps. The report for 1918 shows that 503,300 tons was raised and sent direct to the mill without sorting, the average assay-value being 6·16 dwt. per ton. The yield by amalgamation was 105,250 oz., and by cyanide 43,479 oz., making a total of 148,729 oz., worth £633,022, or 25s. 2d. per ton. The working cost was £476,320, or 18s. 11d. per ton, leaving a profit of £156,702 or 6s. 3d. per ton. The shareholders received £47,500, being at the rate of 5%, while £67,918 was applied to redemption of debentures and expenditure on capital account. The shortage of labour and the floods interfered with operations, and the tonnage treated and the profits were below normal. The reserve is estimated at 2,132,778 tons averaging 6·2 dwt. as compared with 2,103,000 tons averaging 6 dwt. The development has recently shown a distinct improvement.

Langlaagte Estate.—This company was formed in 1889 to work a property on the outcrop in the Central Rand. Two years ago the control was sold by Sir J. B. Robinson to the Barnato group (Johannesburg Consolidated). The report for 1918 shows that 534,060 tons of ore averaging just under 6 dwt. per ton was mined and sent direct to the mill. The output of gold by amalgamation was 88,949 oz., and by cyanide 63,333 oz., making a total of 152,282 oz., worth £647,999, being a yield of 24s. 3d. per ton. The working cost was £508,916, or 19s. 1d. per ton, leaving a profit of £139,082, or 5s. 2d. per ton. The shareholders received £110,812, being at the rate of 12½%. The reserve is estimated at 1,036,200 tons averaging 6·9 dwt., as compared with 1,060,594 tons of similar tenor the year before. Recent developments have given good results. A block of 22 claims has been purchased from the New Era Co., adjoining the south boundary, which will add two years to the life of the mine.

Randfontein Central.—This company was formed by Sir J. B. Robinson in 1907, as an amalgamation of various mining companies operating in the far west Rand, and in 1911 the remainder of the same group were absorbed. Two years ago the control was purchased by the Barnato group. Many rearrangements have been undertaken in connection with mining and milling work. Though a big producer the property has not yielded much profit, but with the new control the chances are greatly improved, though the results so far have been disappointing. The report for 1918 shows that 1,741,388 tons averaging 5·66 dwt. per ton was raised and sent direct to the mill. The total yield of gold was 467,105 oz., worth £1,991,838, or 22s. 9d. per ton. The working cost was £1,883,766, or 21s. 7d. per ton, leaving a working profit of £108,072, or 1s. 2d. per ton. After the payment of £152,107 as debenture interest, and other items, a net loss of £48,911 was incurred. The ore reserve is estimated at 4,254,000 tons averaging 6·8 dwt., as compared with 5,185,000 tons of the same average the year before. Progress is being made with the two new vertical shafts and the new pumping station. Until these are completed, the operations will necessarily be conducted under adverse circumstances.

Lonely Reef.—This company belongs to the Lewis & Marks group, and was formed in 1910 to acquire partly developed gold mines situated 55 miles north of Bulawayo, Rhodesia. The lode is strong and persistent, and the yields have been substantial. The report for 1918 shows that the developments in depth continue to be excellent. The amount of ore treated was 54,320 oz. The yield by amalgamation was 17,674 oz. and by cyanide 31,886 oz., making a total of 49,560 oz., worth £209,712. The working profit was £91,293, out of which £48,273 was distributed among shareholders, being at the rate of 25%; in addition £20,117 was paid as income tax, and £15,969 was written off for depreciation. New levels, the 20th and 21st, were started during the year, and 568 ft. and 120 ft. respectively driven on them to December 31. Here the ore averages 45 dwt. and 29·4 dwt. over 43·5 in. and 30·5 in. respectively. Additional driving has also been done on the 17th, 18th, and 19th levels, with equally satisfactory results. The ore reserve is estimated at 176,097 tons averaging 24·1 dwt., as compared with 145,616 tons averaging 18·69 dwt. the year before. A change in the method of stoping has been introduced so as to prevent so much of the foot-wall rock being mixed with the ore. It is now only necessary, in estimating the reserve, to reckon on the inclusion of 12 in. of wall-rock in the broken ore instead of 24 in. This fact accounts partly for the higher assay-value of the reserve.

Ivanhoe Gold.—This company was floated by the late Whitaker Wright in 1897 to acquire a gold mine at Kalgoorlie from a Melbourne company of similar name, which had done well for its shareholders during the two previous years. After the Whitaker Wright collapse, F. A. Govett became chairman, and Bewick, Moreing & Co. were appointed consulting engineers. The latter firm retired from this position a year ago. For many years handsome dividends were paid, but on the failure to find much ore below the 2,420 ft. level the rate of distribution fell five years ago. The report for 1918 shows that 208,428 tons of ore was treated, yielding gold worth £105,904 by amalgamation, £75,572 from concentrate, £44,832 from sand, and £119,381 from slime, making a total of £345,689. The yield was 33s. 2d. per ton, and the amount left in the residues was 4s. 10d. The net profit was £79,418, out of which £75,000 was distributed as dividend, being at the rate of 7s. 6d. per £5 share. Developments in the upper levels continue to disclose ore, though of lower grade. The reserve is estimated at 1,000,209 tons averaging 34s. per ton, as compared with 1,035,874 tons averaging 34s. 2d. a year ago.

Sons of Gwalia.—This company was formed in 1898 to acquire a gold mine at Mount Leonora, in the North Coolgardie goldfields of West Australia. Bewick, Moreing & Co. are the general managers. Dividends averaging 30% were paid regularly from 1900 to 1917. The report for 1918 shows that 148,394 tons of ore was treated for a yield of 44,725 oz. of gold, realizing £190,092. The working cost was £156,052, and the expenditure on development £20,013. Taxes absorbed £12,649, and administration £2,341, and, after reckoning other small items of income and expenditure, the balance of profit for the year was £71. The yield per ton was 25s. 7d., as compared with 28s. 11d. This fall in the yield, together with the higher wages and the shortage of efficient labour, accounts for the disappearance of the profit. Development has been curtailed owing to absence of available labour. The reserve is estimated at 3 years and 2 months' supply, as compared with 3 years and 8 months' supply a year ago.

Waihi Gold.—This company was formed in 1887 to acquire gold workings in the Thames district in the northern island of New Zealand, which had been originally started in 1878. The early developments were not encouraging, and it was not until 1893 that the first dividend was paid. From that date the output and profits steadily advanced for seventeen years, and Waihi ranked as one of the great gold mines of the world. In 1910 developments at depth began to show less satisfactory results, and since then the amount of ore raised and the gold extracted have been less than half what they were during the previous six years. The report for 1918 shows that 188,998 short dry tons was treated, yielding gold and silver realizing £387,065. The ore assayed 7·4 dwt. gold and 2⅜ oz. silver per ton, and the residues contained 0·5 dwt. gold and 9 dwt. silver per ton. The profit was £199,274, out of which £99,181 has been distributed as dividend, being at the rate of 20%, £42,851 has been reserved for income tax, and £16,752 has been written off for depreciation. As mentioned a year ago, the scarcity of labour and the difficulty of obtaining the necessary pumping plant have combined to prevent all development below the 11th level. When these disabilities are removed, the directors intend to place £50,000 to a special development account. A small amount of development has been done on the 11th level and above, but this has not prevented the ore reserves from being considerably depleted. The reserves stand at 602,789 tons in suspense account, and 556,761 tons in general account, as compared with 622,680 tons and 653,716 tons the year before.

Gurum River (Nigeria).—This company was formed in 1911 by Oliver Wethered to acquire, from the Anglo-Continental Mines, alluvial tin ground on the Gurum river, five miles north-west of Naraguta, Nigeria. The Niger Company took an interest in 1916, and that company's engineers, Laws, Rumbold & Co., were appointed directors of mining operations. The report for the year ended September 30 last shows that 101 tons of tin concentrate was recovered, selling for £18,279, and that the profit for the year was £7,056. The company owns a half share in another property, jointly with the Rayfield (Nigeria) Tin Fields, and negotiations are in hand to sell this half share to the Rayfield company. The company purchased a large interest in the Kuru Syndicate, which recently acquired a property from the Jantar company, and has already disposed of part of this holding at a substantial profit.

Balaghat Gold.—This company belongs to the John Taylor & Sons group of gold mines in the Kolar district, Mysore State, South India. From 1900 to 1907 good dividends were paid, but of recent years it has not been possible to do more than meet expenses. The report for 1918 shows that 26,745 tons of ore was milled for a yield of 19,710 oz. of gold bullion, and that 54,130 tons of tailing gave 4,836 oz., making a total of 24,546 oz., worth £93,835. The working profit was £5,072, out of which £3,543 had to be allowed for depreciation. The year began with an adverse balance of £22,940, and this now stands at £21,151. Developments have been confined to the Balaghat lode, and work has been abandoned on the Main lode. At several places ore has been found between the 3,425 ft and 3,675 ft. levels. The reserve is estimated at 38,614 tons, as compared with 30,076 tons the year before. The accumulated sand and slime awaiting treatment was 10,000 tons on December 31. In addition 270,000 tons of old sand residue can be re-treated at a profit. The directors consider it advisable to increase the amount of development, and propose to issue shares to provide the necessary capital.

Hutti (Nizam's) Gold Mines.—This company was formed in 1901 to acquire from the Hyderabad (Deccan) Company certain gold-mining properties in central India. Milling started in 1903, and dividends were paid fairly regularly from 1904 to 1916. The report for 1918 shows that 23,100 tons of ore was treated, yielding gold worth £37,599 by amalgamation, and £7,777 by cyaniding, making a total of £45,376. The yield per ton was much less than during the previous year, being 9 dwt. as compared with 12 dwt. The total revenue was £47,323, and the cost £48,054, leaving a loss of £731 on the year's working. The developments have not been satisfactory recently, and no workable ore has been found on the bottom level at 3,450 ft. The ore reserve was estimated on December 31 at 9,900 tons averaging 9 dwt. Unless further supplies of ore are revealed during the next month or two, the future policy of the company will require consideration.

Plymouth Consolidated.—This company was formed by Bewick, Moreing & Co. in 1914 to acquire an old gold mine in Amador County, California, which had been reopened by W. J. Loring, one of the partners of the firm. Dividends have been paid continuously since 1915. The report for 1918 shows that 125,300 tons of ore was treated, yielding gold worth £143,686, being a yield of 22s. 11d. per ton. The net profit was £29,497, out of which £24,000 was distributed as dividend, being at the rate of 10%. Development has given good results during the year. In the north shoot at the 2,450 ft. and 2,600 ft. levels, the results have been most satisfactory. To the south of the shaft the ore-body disclosed on the 1,400 ft. and 1,500 ft. levels has continued to develop ore. The latest cables show that the developments have continued to be satisfactory down to the 1,600 ft. level.

Mining Corporation of Canada.—This company was registered in Canada in 1914 to consolidate the operations of the Cobalt Townsite, Cobalt Lake, and City of Cobalt silver-mining companies, and to purchase property from the Townsite Extension. Sir Henry Pellatt is chairman, and D'Arcy Weatherbe is consulting engineer. The report for 1918 does not give details of the output of the individual mines, but states that the City of Cobalt mine has given the bulk of the output though at a reduced rate, that the Cobalt Lake was exhausted during the year, and that the reserve at Cobalt Townsite has rapidly dwindled. As regards the City of Cobalt, there is still a large reserve, but little ground is left for further development. During the year, the output was as follows: 120·9 tons of high-grade ore, containing 245,895 oz. silver, shipped to smelters; 42,355 tons of milling ore, yielding 1,148,709 oz. in concentrate and 272,739 oz. by cyaniding the tailing; 17,632 tons of accumulated tailing re-treated, giving 25,901 oz. in concentrate and 15,006 oz. by cyaniding tailing. The total yield was 1,708,252 oz., as compared with 4,485,541 oz. the year before. The income from the sale of silver was $1,880,965, and the mining profit before allowing for administration and taxes was $990,473. The dividends absorbed $1,348,790. Though the output has fallen, the company has been greatly helped by the high price of silver. Mr. Weatherbe's report on investigations in connection with new properties is quoted elsewhere in this issue.

Nipissing Mines.—This company was formed in the United States in 1906 to work silver mines at Cobalt, Ontario, but was re-registered under Ontario laws in 1917. The metallurgical operations at these mines have been described from time to time in the Magazine. The report for 1918 shows that further modifications were made, amalgamation of the high-grade ore being abandoned owing to the exorbitant price of mercury. The output of ore was 81,347 tons, of which 1,073 tons was high-grade, and 80,274 tons low-grade. The yield of silver was 3,701,416 oz. In addition the company treated custom ore and bullion, while 2,157 tons of residue averaging 9·03% cobalt was sold. The dividends for the year absorbed $1,800,000. The reserves are estimated at 2,788 tons of high-grade ore and 121,049 tons of milling ore, containing 6,000,000 oz. of silver, and further supplies may be expected, but the directors are busy investigating new properties.

THE CONSOLIDATED MINES SELECTION COMPANY, LIMITED.

Directors: Walter McDermott (*Chairman*), J. A. Agnew, F. W. Green, R. J. Frecheville, Louis Oppenheimer, B. Kitzinger and J. S. Wetzlar (*Managing Directors*). *Secretary and Head Offices:* C. W. Moore, 5, London Wall Buildings, London, E.C. 2. *Formed* 1897. *Capital issued:* £552,500.

Business: The finance and management of mining properties, particularly in the Far East Rand.

EXTRACTS FROM THE DIRECTORS' REPORT.

The accounts show a profit of £170,646, including the sum of £10,311 brought forward from last year. The directors recommend the payment of a dividend of 30%, less income tax, and that the sum of £20,000 be placed to the reserve account. As regards the financial position, the balance sheet shows that cash and cash assets, as on December 31 last, exceed the total of current and contingent liabilities by £228,603. Properties and unquoted securities, as valued by the directors, stand in the books at £22,979, while quoted securities taken at cost or under, but in no case higher than the market price at December 31, 1918, amount to £635,164, making a total of £658,143. These quoted securities, if taken at prices ruling at December 31, 1918, would show a substantial appreciation over their valuations on the books.

The net profit for the year ended December 31, 1918, amounts to		£160,335 8 5
Arrived at as follows:		
Net Profits realized on Sales, Commissions, &c.		£103,647 6 3
Interest and Dividends		94,677 0 1
Transfer Fees ...		253 12 0
		£198,577 18 4
Against which had to be written off:		
Expenses, &c.	£6,827 18 11	
Debenture Interest ..	4,523 0 0	
Cost of Investigations, Claim Licences, Depreciation of Office Furniture, &c. ...	9,854 0 11	
Income Tax London, and Taxes Johannesburg	17,037 10 1	
		38,242 9 11
		£160,335 8 5
Which, with the credit balance from last year of		10,311 9 2
Gives a total available profit of		£170,646 17 7

Having regard to the continuation of war conditions practically throughout the year under review and to the numberless difficulties and restrictions under which business has been carried on, the directors regard this result as satisfactory.

Particulars of subsidiary companies, the Brakpan Mines, and Springs Mines, are given in the reports of those companies.

Your company accepted a substantial participation in the subscription of the capital of £1,400,000 of West Springs, Limited, the company formed to work the West Lease Area on De Rietfontein of 2,236 claims for which the tender of the Anglo-American Corporation of South Africa, Limited, was accepted by the Union Government. The capital was subscribed at par, the guarantors receiving 5% commission. Of the 1,400,000 shares, 400,000 shares were paid in full, while 2s. per share was paid up on the balance of 1,000,000 shares. The technical management and control of West Springs, Limited, has—by arrangement with the Anglo-American Corporation of South Africa, Limited—been vested in The Consolidated Mines Selection Company, Limited. The company was registered on June 14, 1918, and work on the ground was at once taken in hand. Two shafts are being sunk, and one haulage way is already well advanced into the property, while other levels are approaching it.

The capital of the Daggafontein Mines, Limited, at December 31 last stood at £730,000 in shares of £1 each, of which £699,765 were issued, all in shares of £1 each fully paid. During the year under review it became necessary to provide for further funds in order that the operations of the company might be carried on without interruption. With this end in view an agreement was entered into with the Consolidated Mines Selection Company, by which that company undertook to lend (or procure loans under its guarantee) the funds required until March 27, 1919, up to a total of £100,000, interest 1% above Bank Rate, with a minimum of 6½%. The Consolidated Mines Selection Company, Limited, further to have 2½% cash commission and the right to call at par any shares not taken up by holders of the options maturing on March 27, 1919. An application has been made to the Government of the Union of South Africa to have the farm proclaimed and the mynpacht located. A proposal has been submitted to the Government in terms of the Transvaal Mining Leases and Mineral Law Amendment Act, 1918, for the grant of a lease of the mining rights of an additional area on Daggafontein in order to constitute a workable mining proposition; with the same object in view a provisonal agreement has been entered into for the purchase of 173 claims on the Farm Daggafontein. No development work was done during 1918, the workings having been inaccessible during the greater portion of the year on account of water. The difficulties have now been overcome and development work was resumed in February, 1919. No. 2 shaft was sunk 509 ft. during the year, the total depth at December 31, 1918, being 1,028 ft.

The capital of the New Era Consolidated, Limited, remains £100,000 in 400,000 fully paid shares of 5s. each. The feature of outstanding interest in this company's business for 1918 was the sale of its 22 claims on Langlaagte for £600 per claim, or a total of £13,235. The New Era Consolidated also participated to a moderate extent in the provision of the capital of West Springs, Limited. A dividend of 20% was paid for the year 1918.

In view of the great prominence which the shares of the Burma Corporation have attained of late, the directors are pleased to state that your company's interest, represented by its shareholding in the Bawdwin Syndicate, remains undiminished. The Bawdwin Mine has continued to open out in a remarkable manner and a large tonnage of high-grade ore has been developed during the year, so that the future of the property is assured in the matter of ore reserves. A good working profit already results from the smelting plant in use, but heavy capital expenditure in the construction of concentration mill, water power plant, and new smelting works will be necessary for another year or two.

Your company's interest in shares of the Itabira Iron Mine, a most promising venture, remains unchanged, but an additional interest has been acquired by way of participation in a loan to the company carrying certain rights to ordinary shares.

CONSOLIDATED MINES SELECTION CO., LTD.

REPORT OF MEETING OF SHAREHOLDERS HELD IN LONDON ON MAY 27.

The twenty-third ordinary general meeting of the shareholders of the Consolidated Mines Selection Company, Ltd., was held on May 27 at Winchester House, London, E.C., Mr. Walter McDermott (Chairman of the company) presiding.

The Secretary (Mr. Charles W. Moore, F.C.I.S.) having read the notice convening the meeting and the report of the auditors,

The Chairman said: I have to propose: "That the directors' report, balance sheet and profit and loss account, as presented, be and they are hereby approved and adopted." Assuming that you will take the report and accounts as read, I will give some details and make some statements bearing on the position and prospects of the company before putting to the meeting the resolution I have just read. In the accounts you will see that the capital is unchanged at £552,500, in 10s shares, and outstanding debentures are reduced to £84,100. Sundry creditors at £119,394. 9s. 5d are higher than last year by £44,741. 7s. 4d., and contingent liabilities have increased by the large sum of £105,525. The advances in these two items, while requiring consideration as serious obligations, must also be looked at as evidence of active current business and of provision for coming operations in the properties which chiefly interest us and which require growing capital outlays. Against the liabilities you will find on the credit side of the balance sheet debtors and debit balances amounting to £134,294. 14s. (inclusive of dividends due to us); also cash and liquid assets of £334,388. 13s. 6d. Properties and securities stand in the books at a total of £658,143. 13s. 6d., and are taken on our usual basis of valuation of cost or under. The market valuation of some of our quoted securities has at times since December 31 been lower than when the accounts were made up, but, even at those reduced market quotations, our securities would show a very substantial excess over the sum taken as a credit in the balance sheet. In passing I should like to impress on you the fact that such fluctuations of market price as have occurred since December in several of our securities can serve as a striking illustration of the necessity for both a reasonable valuation of assets in our books and for keeping up a reserve account as insurance against risks of losses.

The profit on the year's working, at £160,335. 8s. 5d., is only about £4,000 less than that of the preceding year, although at our last meeting I warned you not to expect a repetition this year of the dividend we were then able to recommend. We may consider ourselves fortunate, I think, that the warning proved unnecessary by reason of certain successes we had in our business; and, furthermore, I am able to repeat this year that our earnings were obtained without any reduction in the extent of our principal dividend-earning holdings, which represent the chief mining interests we have shown our confidence in for so many years. We have again applied £20,000 out of profits to increasing the reserve account, which will bring this up to £100,000. I shall put to you a resolution to declare a dividend of 30%, less income tax, which—if you approve of the declaration—will leave a carry forward to next year's accounts of £32,550. 0s. 1d., including the balance from last year, and subject to further remuneration to directors and managing directors in London and Johannesburg.

The directors' report has given you the salient mining points of the properties forming the principal part of our South African investments, and this year I shall say little in the way of detailed description of the several mines themselves, but dwell more on the general view of our business and prospects. Probably you will all have noticed that the shares of Brakpan and Springs Mines have both suffered at times a marked falling off from their high-water marks, and you may have remarked also that in the estimates of ore reserves there have been on occasions unfavourable readjustments of former calculations by our consulting engineer. The two facts have, of course, some relationship. On several occasions I have explained at these meetings the nature of the Rand gold deposits in our eastern areas, which results in a remarkable regularity of average productiveness over long periods, but this is made up of considerable variations between short periods of development. If you consider that market fluctuations over short periods represent the general public appreciation of the temporary variations in development results, you can take a chart of the ups and downs of share prices in a single mine—say, the Brakpan—as representative of local irregularities and general regularity in productiveness of the areas of ground as developed and worked out. This history of our company, interested as we have been in several large properties for many years, may be taken as a still wider illustration of the fluctuations in the progress of the development of the Far East Rand. I have more than once pointed out that our company sinks or swims with the large mining areas we are interested in, and in which our steadily-increasing commitments have been pointed out to our shareholders year after year. To prevent your attaching too much importance to the readjustments of calculations on ore reserves, I will explain that in the system of opening out a mine like Brakpan some very large blocks of ore have to be assumed as put in sight and have to be taken as of a value indicated by the assays made in the course of the various openings around them; but in the cutting up of these large blocks during subsidiary development local variations in thickness and value of reef come to light, which necessitate changes in tonnage and value calculations of the profitable reserves either one way or the other.

During the years we have been successfully working the Brakpan the average results have been so satisfactory over the large area explored that we were induced to take up the Government Deep Level Areas, in belief of a continuance of the past regularity of productiveness into the new ground—a policy which was explained fully at our meeting of May 12, 1917—and this policy was again pursued in the case of Springs, which was laid before you at our meeting of May 25, 1918. If we are ever proved to have erred in these hopeful long-view policies by the future course of developments of the new areas absorbed, we shall be disappointed in good company, for the State Mining Engineer of the South African Government recently made an estimate that the Government's share of profits of working should aggregate for Brakpan £2,500,000, for Springs £5,550,000, and for West Springs £6,250,000. The particular form of nationalization of mining constituted by our partnership with the Government is not quite like that we have heard so much about in England of late. It is a kind which permits of optimism on the part of Government officials, because the Government takes no risks, has no management troubles, and shares only in the profits. The calculation of the Government engineer as to West Springs sheds—by inference—a reflected light of optimism on the future chances of the Brakpan deep level ground; and it represents the strong local confidence in the extended generosity of nature in the distribution of gold values through the undeveloped areas

The mention of West Springs suggests that you will expect to hear something of this property, in which we are now interested both as shareholders and as managers of the operations of the mine. The property lies between Brakpan and Springs mines, and was a Government area, secured by the new West Springs, Ltd., on a sliding scale profit-sharing basis. The Springs Mines, Ltd., is in a very favourable position to drive at once into the West Springs ground, and thus begin development of the new mine long before any shafts sunk from the surface could reach the reef. A cablegram just received gives the latest driving as showing for the last 35 ft. an average assay-value of 8·7 dwt. over 44 in. The advantage thus gained by West Springs, Ltd., is recognized in the working agreement entered into with Springs Mines, and set out in the directors' report which you have received. It was also described in my address to you last year. Two shafts are now sinking on West Springs, but, of course, as in the case of Brakpan and Springs, it will take time before the property will be opened enough to allow of estimating its value, and still longer before it will be producing. The large capital of £1,400,000 required for the development and equipment of this mine was secured by the efforts of the Anglo-American Corporation of South Africa, assisted by our company, the Rand Selection Corporation and financial friends of ours who are accustomed to following our lead in such matters.

In connection with what I have said about the fluctuations in productiveness of mining areas and of the large sums which are risked in their development and equipment, I cannot resist the temptation of saying that I hope continued efforts will be made by those interested to educate our governors and the public on the necessity of recognizing the risks and many losses incidental to gold mining when questions of taxation are under consideration. For instance, when it is considered how much mining adventure has done in opening distant parts of the Empire; what the industry means in the way of affording highly paid occupation directly to thousands of our workers abroad, and indirectly to tens of thousands of workers at home; what a vast wealth is actually added to the Empire; what heavy losses are made by the adventurers against the prizes which are the inducement to take the risks—when these points alone are considered, it is seen that anything like a system of excess profits taxation is absolutely unjustifiable except during the existence of a war requiring every available immediate source of money to be drawn on. If the taxing of all profits beyond a fixed conventional percentage on capital (of which there is some wild talk now) were attempted to be applied to mining generally there would be a very serious falling off of the speculation of the past in new ventures—a speculation which has done so much for the Empire, in spite of some fungus financial growths on the industry. The necessity for leaving the prizes in existence, as an offset to many disappointments and to ever-present risks, is particularly apparent in mining; for it should always be remembered by our law-makers that it is among the very same class of people who make the losses that the present occasional prizes fall as a consolation. They would no longer be prizes if taxed down to some industrial basis of fixed percentage on capital. It is also a very important element in considering taxation that a mine is always a wasting asset, and often a rapidly wasting one. In the matter of encouragement of gold mining within the Empire, it has been questioned by some English financial authorities whether the securing of gold for this country was of any real benefit; but the pretty evident intention of America and other countries to get all they can may have an educating effect; and there are some indications that the Government may not view with apathy the switching off of the gold supply they have controlled during the war.

During the last few months of 1918 mining in South Africa has suffered from the ravages of influenza. This has reduced output and increased working costs, which were already well above those of 1914. In the case of Brakpan our working costs for 1918 were 4s. 8½d. per ton above pre-war figures, and this year development charges per ton will be raised in order to meet the requirements of the mine and prepare for increased milling tonnage. From various reasons beyond our control we are going to be disappointed in the dates at which increases in milling capacity were calculated on when we tendered for the new areas. A great deal is heard of certain labour difficulties, both white and black, but this is common to all countries. There are, however, some peculiarities connected with those in Africa which are interesting in relation to certain fashionable ideas about international solidarity of labour working conditions. In England and some other countries those who largely create and generally control labour difficulties are of the belief that manual labour is alone the effective producer, and should, therefore, alone receive the benefit of the product of labour; but when in Africa the English miner or artisan merely directs the manual labour of the native, but he takes six times the wages of the latter, and will under no condition allow him to do the more skilled or better paid work of the white—which in some cases he could be trained to do—nor allow him to enter the trades unions. At one time, when there was a question of supplying a temporary deficiency in native supply by Chinese, these conditions of African labour were by a political "terminological inexactitude" designated as "Chinese slavery in the interests of mining magnates." The strikes of white labour result frequently in idleness for coloured and native labourers, who, of course, get no strike pay and occasionally suffer greatly in consequence. The natives themselves have begun to appreciate that, if they cannot get the higher-grade work of the white worker, they can at least enjoy the luxury of a strike on their own account when in their opinion desirable. During the war the great drain of good men for the forces has lessened the numbers and reduced the average efficiency of white labour, while influenza has, in like manner, affected the efficiency of the natives.

The developments in the Springs mine have proceeded, on the whole, with quite satisfactory results, and they afford very good promise for the future of the company; but, as in the case of Brakpan, we shall probably not reach the estimates of capacity increases at the dates expected originally, and we shall very likely have periods of slower growth in the profitable ore reserves. The work already done to the south in

... new lease area and developments generally this year have confirmed our favourable opinion of the prospects in this ground. In the case of Daggafontein mine we have had a rather unfortunate year's experience, due to a succession of accidents to machinery and special water difficulties. The latest advices give encouraging results of the resumed developments Both at this and the other mines under our management we have been successful in the adoption of the Francois system of cement impregnation around the various shafts and have thus met the difficulties as they arose; but water has nevertheless caused long delays in the prosecution of much of our preliminary work on all our properties. A readjustment of the boundaries with the Government and the purchase of certain adjoining claims have now increased the area controlled by the Daggafontein Company from 1,436 to 2,059 claims, and it now immediately adjoins the Springs Mines area. This readjustment has been obtained on the reasonable terms of the issue of 69,000 additional shares and the granting of a small share of any future profits of the company to the Government on a sliding scale.

As regards our mining interests outside of South Africa, I think there is nothing I can usefully add to the general statements in the directors' report.

In the matter of finances we have pretty large commitments in the various properties we are managing, and the work laid out before us will fully occupy our attention for several years to come, so that, while we always keep our eyes open for new business of any really tempting nature, we are not in a position of having to hunt for occupation. We have been fortunate in having for co-operation with us the Anglo-American Corporation, the Rand Selection Corporation, New Era, and many individual friends, without which assistance we could not have attempted the very large financial operations of the last three years, and with this assistance we feel capable of looking into similar operations for the future if they should present themselves. The increase of our management work in Johannesburg seemed to require a change in our organization there, and to carry out the plans we have in view it was thought desirable to make Mr. E. Oppenheimer a director of the company resident in South Africa, and who has lately returned there with a full knowledge of the policy of the London board in the conduct of the work in hand. Mr. C. E. Knecht has resigned, and we have appointed Mr. Carl R. Davis, late manager of Brakpan, to succeed him as consulting engineer. Mr Brodigan, who was the original manager of Brakpan, resumes that position. We shall ask you to confirm the appointment of Mr. J. A. Agnew as a director of the company, and in so doing I have no hesitation in saying that his professional mining experience, knowledge of company work and personal character all justify our belief that he will be really useful on our board. As you are all aware the offer of the enemy shareholdings was very generally accepted by the British shareholders and shareholders in Allied countries. Over applications were received, and the directors allocated the shares on a perfectly fair and uniform system. Since that operation was completed here the Rand Selection Corporation and New Era Company have likewise purchased the enemy holdings from the Public Custodian in South Africa. Our staff in Johannesburg and London have had all the worries, difficulties and extra work of the war period to struggle against for the whole of the year under review; and the difficulties did certainly not become less, but rather more, with each successive year, so that we owe them thanks for efforts made which have resulted in very satisfactory general results for the year 1918. The effects of the war are not over, if the war has ceased, and we, as in all other industries, have to face changed conditions, the results of which cannot be forseen.

The dividend we can recommend this year is a good one, but shareholders have had to go through a number of lean years, and the board felt that as long as the earnings were actually there, and with the reasonable precautions adopted of a good reserve account and conservative estimate of assets, profits should be distributed rather than retained on account of any pessimistic anticipation of non-recurrence. However, although it may appear that I was a little previous last year in my warning, I do not hesitate to say again today, that it would not be wise to look upon 30% as the regular dividend to be expected. I will ask Mr. Green to second the resolution which I have read to you, but before putting it to the meeting I will offer to shareholders present the opportunity of asking any questions.

Mr. F. W. Green seconded the motion, which was carried unanimously.

The Chairman: The next resolution which I have to propose is: "That a dividend of 30% (3s. per share), less income tax, be and the same is hereby declared payable to all shareholders registered on February 21, 1919; that the sum of £20,000 be placed to reserve accounts and that the balance of £32,550 be carried to next account."

Mr. A. Roten seconded the motion, which was unanimously adopted.

Mr. J. O. Kettridge proposed that Messrs. Walter McDermott and Frederick William Green be re-elected directors, and that the appointment of Mr. John Alexander Agnew to a seat on the board of directors be confirmed.

Mr. W. E. Ross seconded the motion, which was unanimously agreed to.

On the proposition of Mr. Gibb, seconded by Mr. H. Claridge, Messrs. Deloitte Plender Griffiths & Co. were reappointed auditors of the company for the ensuing year.

Mr. Alfred Hicks moved a vote of thanks to the Chairman and directors. Shareholders appreciated the dividend, and the caution the directors had exercised. He would include in the vote of thanks the staff in Johannesburg in view of the difficulties they had had to contend against.

Mr. Alfred Jones seconded. The directors would appreciate the very quiet and calm way in which everything had been taken that day; it was the highest compliment that could be paid to any board. If things were not going smoothly, there were plenty of speakers to be found.

The motion was unanimously accorded.

The Chairman, in returning thanks, said he was greatly obliged, speaking for himself and the board, and also on behalf of the staff. He was justified in expressing the appreciation they would feel in having this vote to them moved from the other side of the table. He did not think they often failed themselves, when addressing shareholders, to refer to the actual work of the staff abroad as well as at home, and they appreciated very much that the work which they did should be equally acknowledged by the shareholders generally as it was by the board.

The proceedings then terminated.

UNION CORPORATION, LIMITED.

(Incorporated in the Transvaal).

Directors: Joseph Temperley (*Chairman*), Henry Strakosch (*Managing Director*), Sir Carl Meyer, Count Jean D'Ayguesvives. *Secretary:* V. G. Ronketti. *Offices:* Johannesburg 94, Main Street. London: Pinners Hall, E.C.2. *Formed* as A. Goerz & Co. in 1897. *Capital issued:* £875,000, in shares of 12s 6d each

Business: The finance and management of mining properties on the Rand and elsewhere.

EXTRACTS FROM THE REPORT OF THE DIRECTORS FOR THE YEAR ENDED DECEMBER 31, 1918.

At extraordinary general meetings held on August 30 and September 21 last, the name of the company was changed from "A. Goerz & Company, Limited" to "Union Corporation, Limited," and the change duly became effective on October 16 last.

The profit and loss account for the year shows a realized net profit, after deducting all outgoings, including commissions and bonuses paid to the management and staff, of £145,380. 9s. 7d. Including £24,983. 19s. 4d. brought forward from 1917, there is an amount of £170,364. 8s. 11d. to be dealt with. The directors have decided to place £20,000 to reserve account and to declare a dividend of 12% (1s. 6d. per share), involving an amount of £105,000, and leaving £45,364 8s. 11d. to be carried forward to new account.

The holdings of shares, debentures, and other securities and sundry participations and interests are taken into the accounts either at cost or at the market price of December 31, or in cases where no market price exists at the directors' valuation, whichever may be the lower. Our interests are largely centred in the following companies: Geduld Proprietary Mines, Klerksdorp Exploration, Land & Estate Company, La Fe Mining Company, Modderfontein Deep Levels, Princess Estate & Gold Mining Company, Randfontein Deep, San Francisco Mines of Mexico, Van Dyk Proprietary Mines, Withok Proprietary Company. In addition, we have holdings of shares in a considerable number of other companies.

For the Rand gold-mining industry as a whole 1918 has been a disappointing year. Notwithstanding the adverse conditions, the Far East Rand district has made a continued advance and increased both its output and dividends. The mines of our group continue to show an increase in the production of gold, the figures for the last five years being: 1914, £846,646; 1915, £1,607,773; 1916, £1,830,604; 1917, £1,970,786; 1918, £2,073,571. Last year's total was 6% of the Rand's production and 2·7% of the world's production.

The progress of Modderfontein Deep Levels, Ltd., continues uninterruptedly, and the first four years of its milling operations show the following results:

	Tons Milled	Gold Output per ton £	Dividends £
1915	390,000	671,932	175,000
1916	454,000	858,084	337,500
1917	494,400	964,393	425,000
1918	506,100	1,035,473	487,500

The dividend for 1918 was 97½% as compared with 85% in the preceding year. The ore reserves at the end of last year amounted to 3,450,000 tons of the value of 8·8 dwt. (37s. 4d.) per ton over an estimated stoping width of 78 inches, showing an increase of 130,000 tons and a slight improvement in value per ton. Development has continued to show excellent results and the reserves are six years ahead of the mill.

Geduld Proprietary Mines, Ltd., made a further advance during the year and the past five years show the following results:

	Tons Milled	Gold Output per ton £	Dividends £
1914	244,585	395,457	46,125
1915	303,440	468,675	97,000
1916	32[illegible]	504,224	97,000
1917	42[illegible],550	631,364	97,000
1918	513,200	747,906	120,198

The dividend for 1918 was advanced to 11¼% as compared with 10% for the three preceding years, a large proportion of the profits being again utilized for capital expenditure. The ore reserves at the end of 1918 were 2,510,000 tons, of an average assay value of 7·5 dwt. (31s. 9d.) per ton over an estimated stoping width of 61 inches, representing an increase of 310,000 tons for the year, the value being the same as before. These reserves are five years ahead of the mill.

The increase in working costs due to the war, in the case of both the Modderfontein Deep and Geduld Proprietary Companies, have been partly counterbalanced by cheapened production, brought about by increasing the tonnage crushed and by improving the organization and methods below and above ground.

A considerable amount of money being required to sink a third vertical shaft with a view to opening up a new area of the Geduld Company's property, to push on development generally with a view to a further extension of the mill as and when results justify them, and to reduce the absorption of working profits for these purposes, an issue of 180,000 shares was made to the shareholders at the end of last year at the price of 35s. per share, the subscribers receiving option certificates giving them the right to subscribe for 180,000 further shares at 40s. per share until December 31, 1921. The issue was guaranteed by us and our associates in consideration of a cash commission of 5%. By this issue the subscribed capital of the company has been increased from £970,000 to £1,150,000.

At the Princess Estate and Gold Mining Company's property, the reconstruction of the central deep shaft and hauling arrangements was completed early in September. It was almost immediately followed by a severe outbreak of influenza. At one time the native labour supply became very much attenuated, and this, coupled with the losses which had been expected during the period of shaft reconstruction, caused a considerable loss on the year's operations. The position has now improved and better results are expected.

Our interests in Mexico depend very largely upon the price of silver and to a less extent upon the price of base metals. It is unfortunate that the La Fe Mining Company, nine-tenths of whose output value would consist of silver, is still unable to resume operations owing to the condition of affairs in the Republic. Similar considerations apply to the San Francisco Mines of Mexico, though in the case of that company the proportion of silver is smaller. The mine is in a position to earn substantial profits provided that the conditions permit of continuous operations, but unfortunately this is not yet the case.

MODDERFONTEIN DEEP LEVELS, LTD.

Directors: H. Newhouse (*Chairman*), H. C. Boyd, W. R. Crowhurst, F. R. Lynch, V. J. Ronketti, W. Ross. *Secretaries*: The Union Corporation, Ltd. *Head Office*: Johannesburg. *London Office*: Pinners Hall, E.C. *Formed* 1899. *Capital*: £500,000.

***Business*: Operates a gold mine in the Far East Rand.**

The eighteenth ordinary general meeting of shareholders of the Modderfontein Deep Levels, Limited, was held in Johannesburg, on April 23, Mr. H. Newhouse (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts for 1918, said that the year was again one of progress. The only unfavourable feature was an increase in costs of 1s. 2d. per ton milled, due chiefly to the further rise in the price of mining supplies and the higher wages paid to the white employees. This, however, was more than balanced by an increase in the yield to 40s. 11d. and an increase in the tonnage by 11,700 tons to 506,100, the effect of the two being an increase in the working profit by £32,685 to £593,851. The amount available for distribution enabled dividends totalling 19s. 6d. per share, or £487,500, to be paid, the carry forward being increased by £31,201 to £157,676. The development work done during the year totalled 5,425 ft., which was somewhat less than the 1917 total, the deficiency being due to the necessity for economy in explosives during the early part of the year, and the comparative shortage of native labour in the last quarter. The footage was, however, more than sufficient to maintain the ore reserves, which at the end of the year totalled 3,450,000 tons with a value of 8·8 dwt., over a stoping width of 78 inches. This compared with 3,320,000 tons a year previously, when the stoping width was the same but the value a trifle less at 8·7 dwt. Except during the period when recruiting operations were disorganized owing to the Spanish influenza epidemic, the native labour available was sufficient for all requirements, the mine continuing to be a popular one with the natives. Health conditions had been as satisfactory as in previous years, though the death rate from sickness was, of course, not comparable owing to the influenza epidemic. The nil death rate from accidents achieved in 1917 was not maintained, but the rate was well below the average of these fields —only two deaths being due to this cause, equal to 0·9 per thousand. The insurance against interruptions of hauling, in the shape of the dump of ore on the surface, had been practically maintained, only 474 tons having been drawn from this stock during the year, leaving the quantity available at 39,395 tons from stopes and 146,000 tons from development. During the war 68 in all of the company's white employees enlisted for active service, this total being equivalent to about 27% of the average number employed. Of these, four had made the great sacrifice and four had received wounds. It was the intention of the board to commemorate the gallant services of these men by means of a simple though permanent memorial on the mine. The payment of allowances to those who were still serving during last year and to their dependents was continued throughout the year.

The motion was carried unanimously.

TRINIDAD LEASEHOLDS, LIMITED.

Directors: T. J. Milner (*Chairman*), R. H. McCarthy, Major H. L. Sapte, J. L. Siddall, A. W. Rogers (*Managing Director*). *Secretary*: R. M. Macqueen. *Office*: 1, London Wall Buildings, London, E.C. *Formed* 1913. *Capital*: £850,000, to be increased to £1,500,000.

Business: Operates oil-lands in Trinidad.

An extra-ordinary general meeting of the shareholders of Trinidad Leaseholds, Ltd., was held on May 30 at the registered office of the company, No 1, London Wall Buildings, London, E.C., to consider a proposal to increase the capital of the company to £1,500,000 by the creation of 650,000 new shares of £1 each. Mr. T. J. Milner (Chairman of the company) presided.

The Chairman said the production from Forest Reserve field for the six months from July to December was 75,850 tons, as compared with 70,130 tons in the corresponding period of the previous year. They had from time to time encountered on Forest Reserve a heavy flow of oil with great gas pressure at a depth of between 1,500 and 1,700 feet, and on every occasion that they tapped this horizon the well had sooner or later been lost. They had long been endeavouring to find a means of tapping this known large body of oil without the disadvantages which had so far attended it, and various proposals had been considered. The trouble was due to the fact that they had to deal with loose and heaving sands, as well as very heavy gas pressure. Last year they conducted experiments for getting over this difficulty by means of a valve at or near the bottom of the well, combined with the use of an air-lift to supplement any temporary deficiency in pressure and to keep the pipe clear. The appliances which they had had available so far had not been of a sufficiently heavy type to withstand the pressure. The inventor of this process was still as confident as ever that it would prove to be what they were looking for. They had, in addition to the fields they were now operating, very large areas, and the proper course was to develop one or more of these with as little delay as possible. The opening up of a new field, of course, required the expenditure of a large amount of capital, and important sums would also have to be expended upon increased storage facilities and upon extensions to the refinery plant. Although they had made considerable profits during the past two years, and had paid one 10% dividend, they were at the present time in debt to the Central Mining and Investment Corporation to the extent of something over £100,000. They desired to liquidate this debt and also to release a proportion of the current year's profits for distribution to shareholders. They calculated that the balance of the sum raised would be sufficient to finance the extensions in contemplation. The fields they now intended to open up were in the neighbourhood of the pipe-line and shipping port. They did not propose to undertake any immediate development of the large areas in the south-east of the island.

Mr. R. H. McCarthy seconded the resolution, and it was carried with three dissentients.

WANKIE COLLIERY, LIMITED.

Directors: Edmund Davis *(Chairman and Managing Director)*, H. Wilson Fox, D. N. Shaw, W. Rhodes, H. L. Stokes. *Secretary:* A. W. Bird. *Office:* 2, London Wall Buildings, London, E.C. *Formed* 1899, reconstructed 1914. *Capital issued:* £567,259. 10s. in shares of 10s. each.
Business: Operates coal mines in Rhodesia.

The fourth ordinary general meeting of the Wankie Colliery Company, Ltd., was held on June 3 at Salisbury House, London, E.C., Mr. Edmund Davis (Chairman and Managing Director) presiding.

The Chairman, in moving the adoption of the report and accounts for the year ended August, 1918, said that due effect was now given in the accounts to the increase of the capital by 380,000 shares of 10s. each, and of these 324,190 were issued in May, 1918, at 10s. 6d. per share. They had paid a dividend of 5% on June 24, 1918, and a further dividend, also of 5%, on November 1, 1918. These dividends amounted, together, to £56,725. 19s., representing 10% on the increased capital of £567,259. 10s. The dividend of 15% paid in the previous year was on a capital of £405,236. 10s., and the sum paid was £60,785. 9s. 6d. The profit and loss account showed sales of coal, coke, bricks, and fireclay amounting to £250,703. 17s., an increase of £22,518 8s. 5d. compared with the year ended August 31, 1917. The sales of coal and coke for the year amounted to 327,949 and 80,494 tons respectively, as compared with 310,826 tons of coal and 70,827 tons of coke for the previous year. The result of the year's operations was a balance profit of £67,804. 6s. 6d., as compared with £71,202. 10s. 7d. for the year ended August 31, 1917, a decrease of £3,398 as compared with the previous year's accounts. This was due to increased costs. The coal mining and coke manufacture, depreciation, and African general expenses amounted together to £175,850, as compared with £145,842 for the previous year, an increase of £30,000, due chiefly to the increase in wages and salaries and the high cost of mining stores and material. In reference to the present year's operations, they had sold during their first eight months—that is, to April 30, 1919—170,886 tons of coal and 61,032 tons of coke, comparing with 217,382 tons of coal and 52,795 tons of coke for the corresponding months of the previous year. Had it not been for the influenza epidemic and truck shortage, the figures would have shown a great increase over those for the previous year.

They found it necessary from time to time to incur very heavy capital expenditure to equip the colliery so as to provide for a maximum output from the present site, and the capital expenditure in the year under review absorbed £72,400. They had in the first seven months of the current financial year—to the end of March last—outlaid an additional £21,223, and still had very heavy liabilities to face in connection with additions to the screening and washing plant and the erection of 40 retort ovens, which when completed, would mean 140 in operation, when the 49 beehive ovens would be put out of commission.

Their last detailed accounts on the cost of production of coal showed an increase of about 50% on prewar. They gathered by publications in the Press that in Rhodesia there was a desire to secure an additional source of coal supply, and for those who might possibly contemplate embarking capital in such a venture it was only necessary for them to realize that their prewar and during the war—that was to May 1 of this year—price on truck at Wankie for best lump coal was 9s. and 8s. 6d. a ton and nuts 7s. 6d. a ton. These prices, unless controlled by running contracts, they had raised since May 1 of this year to 10s., 9s. 6d., and 8s. 6d. a ton respectively, though such increase in no way corresponded with the addition to their working costs. At the present moment the only available coal deposits in Southern Rhodesia which might be worked outside of those they controlled were in two districts—the one requiring the construction of a line of railway at a cost of at least £600,000, and the other, a small proposition, the coal being of a non-coking nature and more suitable for house purposes than any other, and which could only be made available in opposition to their own supplies for a few small consuming mines in the immediate neighbourhood of the deposit.

They had for some time past taken steps relating to the opening of a new colliery inside their grant. They had sunk a number of bore-holes, proving coal of a good commercial quality and of a thickness of about 28 ft. to 30 ft., comparing with 8 ft., the average thickness worked at on the present colliery. All necessary plans relating to the development and equipment of this new colliery were being prepared, and they hoped at an early date to be in a position to start work on a selected site.

As far as Rhodesia was concerned, they suffered very severely some time back with the influenza epidemic, which practically paralysed mining and other operations in the country, and, added to this, as misfortunes did not come singly, the Odzi Bridge on the Rhodesia Railway system was washed away; so that, in addition to shortage of labour, truck supply became somewhat deficient, these difficulties resulting in a serious reduction of the output. This naturally led to dissatisfaction, so they suggested the appointment of a committee to proceed to the colliery and investigate the causes of the short coal supply. The committee consisted of the Secretary for Mines and Roads, the general manager of the Globe & Phœnix Gold Mining Company, Ltd., the resident mining engineer of the British South Africa Company, the traffic manager of the Rhodesia Railways, and the mechanical engineer of the Gold Fields group. The Administrator of Rhodesia (Sir Drummond Chaplin) was present at a meeting of the Rhodesian Chamber of Mines, and in the course of the speech he referred to the position of Wankie as follows: "Wankie's troubles—As regards coal, the difficulties during the war were very forcibly brought to my mind by the simultaneous appeals I had some six or eight months ago from many quarters. You gentlemen demanded coal for your mines, the Imperial Government was always reminding us that the Congo copper industry must be kept supplied with coal, and the Naval authorities were always reminding us that there must be supplies of coal maintained at Beira for naval purposes. Then there was an outbreak of some sickness at Wankie, which was later followed by the influenza epidemic. With all these difficulties I think we are lucky that we came out as well as we have done. I have great sympathy with the management of the colliery in the difficulties with which they have to contend."

Mr. H. Wilson Fox seconded the resolution, which was carried unanimously.

LONELY REEF GOLD MINING CO., LTD.

Directors : C. F. Rowsell *(Chairman)*, W. F. Andrewes, G. R. Lewis, Isaac Lewis, H. D. Lewis, J. Palca. *Secretary :* A. D. Owen. *Office :* 34, Bishopsgate, London, E.C. *Formed* 1910. *Capital issued :* £271,007.

Business : Operates a gold mine in Rhodesia, 40 miles north of Bulawayo.

The ninth ordinary general meeting of the Lonely Reef Gold Mining Company, Ltd., was held on June 3 at the offices of the company, 34, Bishopsgate, London, E.C., Mr. C. F. Rowsell (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, said that the profit for the year was £91,293, as against £106,142 last year. They had paid two dividends, one of 10% and one of 15%, less tax. Last year he pointed out that the future of the company was then looking extremely bright, and he was very pleased to meet the shareholders again under conditions which were equally favourable. Shareholders would have read with great interest the very complete report presented by the consulting engineer. The most salient feature of it was the position of the ore reserves. These at the end of December, 1917, amounted to 145,616 tons, of the value of 18·69 dwt. At the end of December, 1918, they were 176,097 tons, of an average value of 24·1 dwt. He thought they would agree with the consulting engineer that the increase in the average grade of the ore was remarkable. The quarterly report to March 31 had just been received, and from this it appeared that the ore reserves to March 31, 1919, were 182,788 tons, of an average grade of 24·36 dwt., thus showing an increase of 6,700 tons in quantity and an increase of 0·26 dwt. in value. Mr. Kingston stated that the increase in the average grade was due in part to the high grade of reef developed and in part to the change in method of calculating the reserve which was made possible by the altered method of stoping. Another striking fact which appeared from the consulting engineer's report was the remarkably satisfactory developments which they were securing in the lowest levels. The average value between the 15th and 16th levels was 24·9 dwt., and the value increased in depth until between the 20th and 21st levels it was 34·24 dwt. The constant values in depth were extremely reassuring as to the future of the mine and justified a very hopeful view. Turning to the question of the mill, it could not be said that the working costs were a source of satisfaction. They were 30s. 4·3d. per ton during the year under review, as against 28s. 9·5d. in 1917. The total working costs amounted to 42s. 6·9d., as against 39s. 0·6d. in 1917, being an increase of 3s. 6·3d. per ton. This was largely explained by the recent epidemic of influenza, the direct expenditure in connection with the epidemic being £2,556, equal to 11·29d. per ton. Since the end of the year they had for the four months crushed 18,630 tons at a working cost of 47s. 2d. and a working profit of 61s. 6d. per ton.

Mr. W. F. Andrewes seconded the resolution, and it was carried unanimously.

RHODESIA GOLD MINING & INVESTMENT CO., LTD.

Directors : C. F. Rowsell *(Chairman)*, Isaac Lewis, G. R. Lewis, G. H. Pauling, Julius Weil. *Secretary :* A. D. Owen. *Office :* 34, Bishopsgate, London, E.C. *Formed* 1910. *Capital :* £300,000.

Business : The finance and management of mines, particularly gold mines in Rhodesia.

The ninth ordinary general meeting of the Rhodesia Gold Mining and Investment Company, Ltd., was held on June 3 at 34, Bishopsgate, London, E.C., Mr. C. F. Rowsell (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, said that during the past year they had realized a profit on shares sold of £5,397; interest and dividends amounted to £10,713, against £5,708 last year, and rentals and royalties to £1,376, against £1,032, the total revenue being £17,540. Deducting expenses, British income tax and depreciation, there was a net profit of £12,506, against £4,405 last year. Properties, etc., stood at £103,009, against £90,271, the increase being due mainly to the purchase of the Huntsman property. Shares amounted to £227,638, against £234,073, the reduction being due to the sale of a small number of Lonely Reef shares. Loan accounts stood at £36,532, against £35,203. The £12,250 due by the Cam and Motor would be repaid under the reconstruction scheme which had just been approved by that company. The cash resources amounted in all to £13,000, against £7,600 last year. The credit to the profit and loss account now stood at £55,412, against £42,905 last year. Dealing with the company's various assets, he stated that they owned 27,861 shares in the Lonely Reef Gold Mining Company. The position of that company was undoubtedly a very sound one. The Cam and Motor company, in which they owned 43,000 shares, had passed a reconstruction scheme which would place the company in a sound financial position, as they would be enabled to repay the whole of the debentures, the bank overdraft and other debts, including £12,000 advanced to them by this company. The consulting engineer, Mr. Kingston, had a very high opinion of the property and believed that it would become a prosperous and dividend-earning company. The Sabi Company was now receiving a revenue on a fairly substantial scale from its tribute, and this company was receiving from the Bernheim mine also a satisfactory revenue from the tribute of that mine. Mr. Kingston, after very careful consideration of the development of the property, advised the directors to exercise their option on the Huntsman claims, and they had accordingly done so. The property had ore reserves, calculated over reef width, plus 12 in., of 12,029 tons of the average value of 13·77 dwt. Mr. Kingston, in his report, stated that it was too early to determine the real value of the mine, but a prospect that developed ore during the option period of sufficient value to pay for the purchase of the mine and the cost of development and equipment was a prospect of exceptional merit, and its further development was looked forward to with special interest.

Mr. Lewis seconded the motion, which was carried unanimously.

ANGLO-CONTINENTAL MINES CO., LTD.

Directors: W. F Turner (*Chairman*), Edmund Davis, E. W Janson, Hetherington White *Secretary:* A. W Berry. *Office:* 22, Austin Friars, London, E C.2 *Formed* 1909 *Capital issued.* £155,000 in 10s shares.

Business: The finance and development of mines in Nigeria and investment in mining shares generally.

The ninth ordinary general meeting of the Anglo-Continental Mines Company, Ltd., was held on May 28 at Winchester House, London, E C., Mr. W. F. Turner (Chairman of the company) presiding.

The Secretary (Mr. Alfred W. Berry) having read the notice convening the meeting and the report of the auditor,

The Chairman said: We submit to-day the directors' report for the year ended December 31, 1918, together with the balance sheet and profit and loss account. A year ago I said that we hoped that when the time came the results for the year would be found to be at least equal to those of the year which was past, and that is practically what has happened. You will see from the balance sheet that the amount standing to the credit of profit and loss account is £29,365, which is only about £200 less than the corresponding figure of the previous year. Consequently last year's dividend is maintained, that is, 15% free of income tax, or, expressed in other words, something over 21% less income tax. This requires £23,250. We have to provide £1,332 for income tax and £1,104 for directors' further remuneration This last item requires a word of explanation. Under the articles of association the directors are entitled to a further remuneration of 10% of all dividends paid in excess of a cumulative dividend of 10% per annum. This provision has been in abeyance owing to the fact that no dividend was paid for 1914, the year of the outbreak of the war, and only 7½% for the year 1915, but the increased dividends for the years 1917 and 1918 bring it into operation again. It is interesting to know that the average dividend paid during the nine years of the company's existence is 11% per annum free of income tax, or 13% less tax. The amount to be carried forward to the current year is £3,677.

The earnings for the year are somewhat less than those of the preceding year, but that is due to the fact that our realizations of shares have been on a smaller scale. It would have been an easy matter to have increased these realizations and so to have produced a larger dividend, but taking all the circumstances into account we preferred to content ourselves with the result which is before you. That this was a wise course is proved by the fact that the realizations which might have been made last year can now be effected at considerably better prices.

As regards the other side of the profit and loss account, the expenses are somewhat higher than the year before, as I predicted they would be. On the other hand, the losses written off are only £920, against £3,434 in the preceding year. The balance sheet also corresponds pretty closely with that of the preceding year, and I think it can be regarded as entirely satisfactory. The creditors, £4,579, were almost exactly the same amount as in the preceding year. The cash and war bonds amounted to £45,461, as against £58,426 the year before, which is due to our having increased our investments. The debtors on loan and other accounts, £10,401, are about £750 less than in the preceding year. The investments, £132,582, show an increase of about £13,000. I will refer to these later.

The next paragraph of the report states that no provision has been required for depreciation, as the company's investments show on balance a considerable increase in value. There have been fluctuations, of course, but where the movement has been downward it has been quite unimportant, and where it has been upward it has been appreciable. A valuation on the basis of market prices at December 31 last would show a large surplus, and a valuation on the same basis today would show a still larger one.

The next paragraph deals with our affairs in Nigeria, and it states that the output of tin concentrate from the company's properties was 207 tons. This compares with an output of 271 tons in 1917, a reduction of about 25%. I explained at the last general meeting that considerable difficulties had existed in connection with the change of management in Nigeria and that these difficulties had persisted into the year 1918 with which we are now dealing. I also mentioned that, as time goes on, in working these alluvial and surface deposits in Nigeria the tin becomes more difficult to win at a profit, and that has proved to be the case in regard to the past year. Another difficulty has been the scarcity of labour, due largely to influenza, while another disadvantage was that at one time, owing to the rains, we were unable to get considerable quantities of tin to the railway for shipment, the consequence being that we did not get the benefit of the high price of tin which ruled at one time during the past year. I mention these things because it is so easy to be led away by temporary high quotations for the metal into the assumption that large profits are necessarily being made.

This part of the subject, however, is not so important as might be supposed, for in our case it is dominated by the question of prospecting for new properties. I said at the last meeting that we had made special arrangements for prospecting outside the properties which we already held. That particular effort, however, was not successful. It was cut short by the fact, which is stated in the report, that in the month of July the Nigerian Government issued a regulation withholding the grant of any mining rights outside the existing mining areas, and the regulation continued in force until January 1 this year. This regulation did not actually prohibit prospecting outside existing areas, but in effect it practically amounted to a prohibition, and it was a great disappointment to us. What the gain of this regulation was to the Government I have not yet heard, and it is difficult to imagine. As I have said, it was withdrawn on January 1, and our manager, who had been actively preparing for the opportunity, immediately set to work to secure new ground. In this he has been quite successful.

We have applied for, or acquired, the benefit of applications for exclusive prospecting licences over two groups, one in the Monguna district of 19·3 square miles, the other in the Jos district of about 17½ square miles, together nearly 37 square miles. In the former case we applied for an area of 8 square miles, and we subsequently bought the rights over two adjacent areas of 11·3 square miles, one of these being necessary to us on account of the water supply. The amount of prospecting done is limited, but tin has been proved to exist over the whole area. One of the areas includes some waterfalls, which may prove to be valuable for working our own ground or that of other companies. They are only about 13 or 14 miles from Ropp main camp.

The other group in the Jos district also consists of three areas which have been applied for by ourselves, one of 8·75 square miles, one of 5·6 square miles, and one of 3·25 square miles, a total of 17·6 square miles. We have also applied for two mining leases, one of 110 acres and one of 218 acres, and for five mining rights over various streams having a total length of over 4,000 yards. A good deal of preliminary prospecting work has been done over these areas, and the manager has expressed himself as thoroughly satisfied with the results. In reference to one of these Jos areas, the manager says: "I find it difficult to write about this ground without becoming enthusiastic. There is literally tin all over it where not covered by rocks, but not, of course, all payable. I consider this area very valuable." Speaking of these recent acquisitions as a whole, he says: "You will see that our properties have radically improved, and we now have good reason to believe that some of the new areas, in fact all of them, are likely to be very valuable."

Elsewhere at our Murchison property we have taken up a mining lease over 126 acres, and five mining rights extending over 7,380 yards of streams, and also two others a few miles away extending over 2,500 yards. At the Rafin Gora property we have applied for eight mining rights over a length of 9,010 yards. There is still a good deal of ground to be prospected at Rafin Gora. It must be remembered that we are now in the rainy season, but when active prospecting work is resumed in the autumn I think we may look for important results.

The next paragraph of the report refers to the Mongu (Nigeria) Tin Mines, Limited, stating that the company's interest is unchanged, in other words, we have not sold a single share during the past year or down to the present time. The annual meeting of the Mongu company will be held some time during next month, and in the meantime I need only say that its position and prospects are perfectly satisfactory.

Reverting to the subject of the investments, I have already stated that we retain the whole of our interest in the shares of the Mongu company, which amounts to about half the total issued capital. The present market price is appreciably higher than it was at the end of December last. We have also retained nearly the whole of our Trinidad Leasehold shares. These shares have had a marked rise since December last, and, as you will know from the newspapers, the company is about to make an issue to the shareholders of one new share for every two old shares at the price of 45s., which is about £1 below the present market price. This issue is stated to be made in order to extend the development of the company's properties, and to enlarge the plant so as to cope with the increasing demand for oil, fuel and other products. Having regard to what this company has already accomplished, the large areas it holds, and to all that is going on in Trinidad, there would seem to be plenty of room for still further appreciation in the price of the shares. We have also retained our holding of shares in the Ropp Tin Company, which have increased in value since last December. We have made an investment in the American Trona Corporation, a concern of which you will doubtless have read something in the newspapers, and which should have a great future before it. We have invested in the Rhodesian Broken Hill Development Company, which is developing into a very important enterprise of a permanent character, and we have made other investments, but, as some of them are in the course of realization at this moment, I do not refer to them. We have underwritten a part of two recent issues of capital of the Tin Areas of Nigeria, Limited, and part of a forthcoming issue of capital by the Northern Nigeria (Bauchi) Company, and we have made some small investments in certain low-priced Kaffir shares. I must mention once more our holding in the Mount Oxide Mines, Limited. It consists of about 50,000 shares which are entitled to about 8,000 shares of the Mount Elliott Company of £5 each: The exchange of these shares has not yet been effected, owing to the fact that the sanction of the Treasury could not be obtained during the war, nor is it yet forthcoming. We have always regarded this as a very promising investment, the Mount Oxide Mine being probably the richest copper mine in Australia. The difficulties which have attended it have been due entirely to the war. The Mount Elliott and Mount Oxide Mines, like nearly all the Australian copper mines, are at present shut down owing to the impossibility at the present moment of effecting any sales of copper In the meantime the raising of fresh capital is under consideration, together with a scheme for extending the railway from the Mount Elliott to the Mount Oxide Mine. The realization of this investment on advantageous terms appears to be only a question of time.

Looking at the position of our affairs as a whole at December 31 last, I must describe it as having been very satisfactory, and looking at it to-day, I can only say that it is still more so. There are one or two spots on it, but these are so trifling that they are not worth mention. As regards the current year and the prospects of dividend, I cannot, of course, make any promise, but I can say that at no time in the company's history has the prospect whether as regards capital or dividends, been so good.

I now beg to move: "That the directors' report and accounts, as at December 31, 1918, be and they are hereby received and adopted, and that the dividend of 15% free of income tax, recommended by the board, be and it is hereby declared payable on the 31st instant."

Mr. Edmund Davis seconded the motion, which was carried unanimously.

On the motion of the Chairman, seconded by Mr. Davis, the retiring director (Mr. E. W. Janson) was re-elected.

Mr. Hetherington White proposed that the managing directors (Mr. Edmund Davis and Mr. W. F. Turner) be re-elected.

Mr. Janson, in seconding, said it was entirely owing to the efforts of these two gentlemen that the company was in the successful position in which it found itself on that occasion.

The motion was unanimously approved.

The auditor (Mr. Ralph M. Everett) having been reappointed, the meeting terminated.

ROPP TIN, LIMITED.

Directors: Edmund Davis (*Chairman*), Lord Brabourne, C. H. Holland, J. C. Prinsep. *Consulting and Superintending Engineers*: Consolidated Gold Fields of South Africa, Ltd. *Secretary*: H. St. John Hodges. *Office*: 20, Copthall Avenue, London, E.C. 2. *Formed* 1911. *Capital issued*: £49,541 in shares of 5s. each.

Business: Operates alluvial tin properties in Nigeria.

The seventh ordinary general meeting of shareholders of Ropp Tin, Ltd., was held on June 11 at 8, Old Jewry, London, E.C., Mr. Edmund Davis (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for 1918, said that the balance of profit for the year was £52,150. During the year they had produced 839 tons, and the reserves at the date of the balance sheet stood at 10,986 tons, or a reduction of 587 tons as compared with the reserve at December 31, 1917, showing that the reserves at the date of the last balance sheet—taking into account the output for the year under review—showed an increase of 252 tons, without including any reserves in the four additional mining leases which had been applied for and granted during the year under review. The tonnage which these additional properties should give would naturally add materially to the life of the proposition. They now held sixteen mining rights, covering a total area of 10½ miles of stream, comparing with eight mining rights over a length of 5 miles at December 31, 1917, this very large difference in stream rights adding greatly to the value of the proposition. The capital of the company was ridiculously small, and though at the present the whole amount of £55,000 had been issued, they had only received by way of capital and premium a total of £113,567 (less expenses of issues and commissions, £1,432), and therefore, it had become necessary at various times to borrow on First and Second Mortgage Debentures and loans large amounts to meet expenditure which had to be incurred in order to develop and equip the property on the scale it warranted. In this connection they should bear in mind that the only figure that had ever appeared in the balance sheet, and which still stood on the credit side of the same, under property account was £17,500, and since the formation of the company they had outlayed in prospecting £22,397, on account of machinery and dredges £119,297, on buildings and constructions £30,045, and on furniture and equipment £1,156, and at December 31, 1918, the stock of stores, tools, fuel, oil, etc., on hand and in transit amounted to £32,918, making a total expenditure to date of £223,313. Against this they had at December 31 last, by way of capital and premium £91,732, and they had outstanding First and Second Mortgage Debentures and loans £34,940, making a total of £126,672, and leaving a balance of £96,641. They were of the opinion that it was better to rid the company of part of the indebtedness incurred for capital expenditure, and had resolved to suggest the increase of the capital by £20,000 and to issue to the shareholders pro rata to their holding 55,000 of the new shares at a premium of 13s. 6d. per share. The issue had been underwritten for a commission of 6d. per share.

For the current year there was every indication that the output would be considerably better than for the previous 12 months, though the question of output naturally depended upon the running of the plant, and this, in turn, depended upon the necessary spares being available when required, the matter of spares and supplies for the undertaking having at all times given them great concern. At last year's meeting reference was made to the possibility of some arrangement being come to in the event of their electing to work out the property in a much shorter space of time than originally contemplated; but those concerned did not see their way to approve of the proposition made, and, therefore, no undue increase in production would take place, though the contemplated output should give satisfactory profits if realized at anything like the price which had ruled for the first five months of this year. At their previous meeting he referred to the price realized for the concentrates produced and to expenditure in Nigeria and London in connection with the production, and they now wished to deal with the proposition in a similar manner. Taking, in the first instance, costs for the 12 months ended December 31, 1917, they stated that their expenditure in Nigeria and London, as well as depreciation of plant, machinery, buildings, and furniture, prospecting and development showed an increase of £28 per ton over the previous 12 months. In the present instance there was a further increase of about £23, though, on the other hand, there was an increase in the price realized of about £17, showing a reduction of about £6 per ton in the net profit for the year under review; but after taking into account the various charges, premium on debentures, depreciation, prospecting and development, income tax, debenture interest, interest on loans, there was a net increase of about £7 in the profit per ton, which was satisfactory. Mr. Thorne, who designed the dredges and originally undertook to proceed to the property in order to deal with the proposition, had, after lengthy delays due to the war period, arrived on the property, and was now dealing with the undertaking in a satisfactory manner, which led them to conclude that the output for the current year and thereafter should be on the satisfactory lines they had always expected. He moved: "That the directors' report and accounts to December 31, 1918, as submitted to this meeting, be and they are hereby received and adopted, and that a dividend of 75%, less income tax, on the issued capital of the company be and the same is hereby declared, payable to the holders of the shares in the company registered in the books of the company on the 2nd day of June, 1919."

Lord Brabourne seconded the resolution, which, in the absence of question or comment, was carried unanimously.

The Chairman next moved the re-election of the retiring director, Mr. J. C. Prinsep, and the motion was seconded by Mr. C. H. Holland and unanimously agreed to.

The auditors (Messrs. Deloitte Plender Griffiths and Co.) were then reappointed.

The Chairman further moved: "That the capital of the company be increased to £75,000 by the creation of 100,000 additional shares of 4s. each, ranking in all respects pari passu with the existing shares of the company."

Lord Brabourne seconded the resolution, which was unanimously adopted.

The proceedings then terminated

BISICHI TIN COMPANY (NIGERIA), LTD.

Directors: James Gardiner (*Chairman*), W Graham, W S. Coutts *General Manager*: A W. Hooke. *Secretary*: W W Evans *Office*: 33, Cornhill, London, E C 3 *Formed* 1910. *Capital*: £200,000.
Business: Operates alluvial tin properties in Nigeria.

The eighth annual general meeting of the Bisichi Tin Company (Nigeria), Ltd., was held on June 11 at the Cannon Street Hotel, London, E.C., Mr. James Gardiner (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts for the year 1918, said that the output was only three tons less than that of 1917. This was somewhat of a disappointment in view of the fact that at the date of the last meeting everything was progressing favourably and pointed to an improved production during the remaining months of the year. But in the autumn influences which they could neither foresee nor control became evident, and the epidemic of influenza which appeared on the coast rapidly spread to the plateau in a virulent form. The mortality among the natives and the peculiarly sudden incidence of the disease created a panic under which the labourers abandoned their work and returned to their villages. The shortage of labour thus created very seriously affected the work of the last four months of the year, and even at the present time they had not returned to normal conditions as regards supply. During the first week of August the metal attained the record price of £398. 10s. per ton, but stood at this only for a day or two, when a steady decline set in. By the end of December it had fallen to £232. 10s., and in February the low level of £200 was reached. Since then there had been an improvement. It was fortunate for them that scarcity of tonnage on the coast delayed their shipments, and they thus escaped the lowest level of the market. For the 217 tons of ore already marketed they secured an average of £219. 9s. 11d.—equal to £305 per ton metallic—and the balance, although it would reduce this average, bid fair to be realized at a favourable price so far as the market stood at present.

As regards the future, labour was the chief difficulty, but no doubt this would improve as they got back to normal conditions, and in this connection he could not do better than quote from the manager's letter just received, dated May 20: "The big drop in the output is due to the serious shortage of labour on the plateau. We only have 25% of the labour that we could usefully employ at this time of the year, and the scarcity, coupled with the rearrangement of work due to the change of the season, makes it very difficult indeed. Two of our elevator plants are ready and waiting for water so soon as it arrives. We have had a few passing storms, which have only given sufficient water to hamper our river bed work." He would also mention that the trouble created by the influenza epidemic had been aggravated by the currency question. The scarcity of silver coin led to a Government issue of paper money, and this had been received with suspicion by the natives. The labourers refused to work for paper. He understood, however, that the Government was taking steps to relieve the situation with regular shipments of specie, supplemented by a supply of some form of metal token, of which a definite proportion was to be allocated for the requirements of the mining industry. Given a return to normal working conditions, development work, which had been in abeyance during the past year, would be taken up again as became necessary for the economical working of the mine Up to the present sufficient had been done in advance to enable them to keep up an average output. In this respect he might say that arrangements had been made for the diversion of sections of the river to secure better results from the deposits in the bed thereof in the dry season.

The decline in output for the current year was solely due to the causes already enumerated, but provided that they secured a production during the next seven months approximating to the average of the past seven years over the same period, the total for the twelve months to December 31, 1919, should be about the same as that for which they were accounting that day. With an article like tin it was dangerous to indulge in prophecy, but the figures of supply and demand were such as to encourage the belief that the range of prices would be upward rather than downward, and this should be more clearly defined immediately the uncertainty which prevailed at present in regard to trade prospects was removed by the signing of peace.

In regard to what was of the greatest importance, the acquisition of new ground, the company owned, jointly with the Forum Company, some 3¾ square miles in the Bukuru district. In addition to this, they had since acquired, also on joint account, further exclusive prospecting licenses of 5·4 square miles on the Leri River, 2·08 square miles in the South Bukuru district, and 1 square mile in the Kuru district. On their own account they had also taken up the following in the Bassa district: Eleven mining rights, covering 10 miles 700 yards of stream courses, one mining lease of 61·72 acres in extent and two exclusive prospecting licenses, of which one is 5·2 square miles and the other 3·72 square miles in extent. To his previous reference to prospects for the current year he ought to add that they might reasonably expect soon to obtain returns from some of their own additional, as well as from jointly-held, areas. In this respect they were advised that a camp had been established on the Bassa area and permission had been obtained for tin-winning over certain sections. This new work had entailed an augmentation of the staff, and they were doing their best to meet all requirements with efficient and reliable men. In conclusion he would draw attention to one important factor in regard to the development of these new areas, which must be a great satisfaction to all, and that was they would not require to seek for outside assistance, their resources being ample. He would only venture to add that, although they might have occasional set-backs in the future as they had had in the past, there were more prosperous times ahead of them than they had experienced hitherto, and these on the whole had not been unsatisfactory.

Mr. Wm. Graham seconded the resolution, which was carried unanimously.

On the motion of the Chairman, seconded by Mr. W. S. Coutts, a dividend of 7½% less tax, making 12½% for the year, was declared.

The Chairman then proposed the re-election of the retiring director, Mr. William Graham, saying that that gentleman was a great acquisition to the board.

Mr. Coutts seconded the motion, and it was unanimously agreed to.

GURUM RIVER (NIGERIA) TIN MINES, LTD.

Directors: Oliver Wethered (*Chairman*), Sir Harry S. Foster. *Secretary:* E. J. Andrews. *Office:* 54, New Broad Street, London, E.C. *Formed* 1911. *Capital issued*: £117,303 10s. in shares of 10s. each.
Business: Mining and development of alluvial tin ground on the Gurum river, Nigeria. Also holds interests in other properties.

The annual general meeting of the Gurum River (Nigeria) Tin Mines, Ltd., was held on May 27 at Winchester House, London, E.C., Mr. Oliver Wethered (Chairman of the company) presiding.

The Chairman, after a feeling reference to the death of Mr. H. C. Godfray, one of the directors, said: I am not proposing to detain you for more than a very brief period, but there are points of interest deserving of special comment. The working of our old property was restricted by shortage of labour, but considering the limited amount of work done the result was very satisfactory, and there is every reason to hope that satisfactory output may be expected for several years. Reference to the plan will show that we have a very great length on the river, and also that we are admirably situated in relation to the railway. Messrs. Laws, Rumbold and Co. thoroughly appreciate the great desire we have to develop and work this area on the largest scale possible, and that we are prepared to provide all requisite funds for leats and any equipment which may be required. The report next deals with our interest in certain areas in which we first secured a half interest, and subsequently acquired the other half for the Rayfield (Nigeria) Tin Fields, Ltd. The latter company desire to secure the whole interest for the reason that it can be worked in conjunction with their own properties in the district at such seasons of the year as are most favourable. For instance, some areas have the requisite water during the rains, while other areas are at such a season flooded and unworkable. Your directors are willing to sell for an adequate consideration, and now that Mr. Iles, their general manager, is home, the terms can be discussed and settled.

Next in order is the Kuru interest, which is a very important one, notwithstanding that we sold a portion of it. This transaction was at a figure showing a large profit, but well within the value of the company having regard to its capacity of production, its large reserves and small capital. Our company and its associates paid £50,000 in cash for the property, and provided £10,000 for working capital, and there is no watering or inflation of capitalization, which stands at £60,000. The purchase price asked was based on the profit to be expected from the proved reserves. Since then the existence of tin on other parts of the unexplored ground has been proved, and it may be assumed with every confidence that the Kuru property will produce large quantities of tin for a long time to come. Few companies have been able to give a production of 30 tons per month eight months after production has been started. I have a letter from Mr. Allen, the manager of the Kuru Company, who is now in England for a well-earned rest, and one or two extracts may be of interest: "We have already proved that the Niger Company's estimate as to tonnage was considerably below what actually exists. We have a Banka drill on the way out to Nigeria, and as soon as it reaches the property intend to prove the several other streams within the boundaries of our two exclusive prospecting licences. We have lately opened up a larger deposit of rich detrital on both sides of the main stream, some quarter of a mile south of the old workings. As much as 10 tons was recovered in one week from this one area. Up to the present we have done no work on any of the subsidiary streams, although we know that we have tin in them. You might almost say that the Kuru output depends entirely on the amount of labour available."

We are also interested in the Keffi Tin Mines, Ltd., a company which recently obtained Treasury sanction to issue £50,000 of capital at par, bringing its total capital up to £100,000 and providing a clear £50,000 of new capital. The financial position of that company is very strong and their assets are of undoubted value, with great possibilities.

In the report for 1917 we spoke of the value of the support and co-operation of successful Nigerian undertakings much interested in our success. That support and co-operation has proved to be of the greatest value, and will continue to be so. Our greatly improved position will enable us to more fully share in business which the remarkable development of the field will provide. We are suffering in common with thousands who wish to make good the depleted stocks of spare parts for machinery, tools and other things which nearly five years of war or its effects have caused. For this period everything has been difficult, and one has hesitated to do anything to increase the worries or cause embarrassment to any Government authority under which one is working, but the time has come when strong representations may reasonably be made, and we confidently hope relief may be obtained from the hardships under which our industry suffers. Those matters are being dealt with at the present time through the Chamber of Mines. I mention this point as I find a great many shareholders interest themselves in the question, and I am glad that this is so. Apparently there is practically unlimited capital seeking investment, and it is right and proper that as much as possible should be within the Empire. To attract such capital, reduced railway rates and other reforms and facilities are essential, and given this I have no doubt that Nigerian industry can hold its own with any tinfield in the world. I have not gone into the accounts at all, as they are very simple, but I shall be glad to give you any information upon them. It is infinitely gratifying to me to find that, although the dividend was not actually declared, as I ventured to prophesy it might be, during the then current financial year, we are now paying one, the warrants for which will be posted on Thursday next. I hope it will be the forerunner of many dividends, and that the old shareholders, who have been so patient and faithful through these very dark days, will benefit as well as those who have recently become shareholders in the company. With these remarks I beg to move: "That the report and accounts be received and adopted," and I will ask Sir Harry Foster to second the resolution.

Sir Harry S. Foster seconded the motion, which, in the absence of comment or question, was carried unanimously.

Sir H. S. Foster, in proposing the re-election of Mr. Oliver Wethered as a director, spoke appreciatively of Mr. Wethered's business ability and his capacity for hard work.

JANTAR NIGERIA COMPANY, LIMITED.

Directors: F. W. Janson, P. C. Tarbutt, Oliver Wethered. *Secretary*: E. J. Hayman. *Office*: 18, St. Swithin's Lane, London, E.C. *Formed* 1912. *Capital*: £60,000
Business: Operates alluvial tin ground in Northern Nigeria.

An extra-ordinary general meeting of the Jantar Nigeria Company, Ltd., was held on May 28 at the registered office of the company, 18, St. Swithin's-Lane, London, E.C., for the purpose of considering the following resolution: "That the capital of the company be increased to £90,000 by the creation of 30,000 new shares of £1 each." Mr. Oliver Wethered presided.

The Secretary (Mr. E. J. Hayman) read the notice calling the meeting.

The Chairman, in moving the resolution, said: The circular which accompanied the notice convening this meeting gave you practically all the information there is to be given; but there are one or two points on which a little further data may be interesting. I would remind you that at our last annual meeting we referred to the acquisition of an interest in a company which had been formed, in the shares of which we acquired an interest at bedrock. As a matter of fact, the property was acquired at the suggestion of our manager, Mr. Allen, and the negotiations were carried through, if I may say so, with great pertinacity and skill by our colleague, Mr. Percy C. Tarbutt. We became shareholders in a property of extraordinary promise—in fact, more than promise—which was capitalized at £60,000. It actually cost the contributing companies £50,000 in cash, and £10,000 was provided for working capital. There was, therefore, no inflation or watered capital, and, with good fortune and energetic management, we find ourselves at the end of six months with a production of 30 tons a month, which, frankly, might be increased. I think there are very few properties in Nigeria—and I speak with experience—with a record as satisfactory as that. When these negotiations were carried out an option was given on two claims in the immediate district, which are known as Kuru 3 and 4, upon which practically no work had been done, although their position on the river beds justified very good hopes. The Jantar Company, which took nothing for negotiating the securing of the original Kuru property, itself retained an option on these properties. Certain work was done, and on the recommendation of the manager our option was exercised, and at any moment when we get permission to win tin No. 3 will be a producer, which will go to swell the returns of Jantar. The acquisition of these two areas puts Jantar in an exceptionally good position, and will undoubtedly prolong its life for many years. In view of this, everybody will be ready to vote for the increase of capital, which, after all, brings it up to only £90,000, and this, judging by past results, is a very moderate one. The shares will be offered pro rata to the shareholders—that is to say, the 20,000 to be issued for cash.

Mr. Percy C. Tarbutt seconded the resolution, which was carried unanimously, and a vote of thanks to the Chairman and directors terminated the proceedings.

GOLDFIELDS OF EASTERN AKKIM, LTD.

Directors: Percy Tarbutt *(Chairman)*, Sir F. M. Hodgson, W. T. Key, J. L. Williams. *Secretary*: E. J. Hayman. *Office*: 18, St. Swithin's Lane, London, E.C.4. *Formed* 1919. *Capital*: £50,000, in 200,000 shares of 5s. each, of which 166,000 have been issued.

Business: The development of gold deposits in the Gold Coast Colony.

The statutory meeting of the Goldfields of Eastern Akkim, Ltd., was held on June 11 at the offices, 18, St. Swithin's Lane, London, E.C., Mr. Percy Tarbutt (the Chairman) presiding.

The Chairman said the meeting was called in order to comply with the provisions of the Companies Act, and was purely formal. As would be seen from the report, 166,000 shares had been subscribed for in cash. In terms of the agreements with the Eastern Akkim, Ltd., and Asiakwa Alluvial Syndicate, Ltd., they had to allot to them or their nominees 34,000 fully paid shares. These companies were now in course of liquidation, and when the necessary formalities had been complied with and these shares allotted, the whole 200,000 shares would have been issued.

The Chairman, in reply to a question, said the company had not yet commenced operations, but they had been very lucky, inasmuch as they had arranged that Mr. John Saxton, who went out to the property originally, should return there. Mr. John Saxton went out in 1911, and carried out certain tests on the property, his report having been made for the old company. In that report the results of the alluvial tests showed that the values of the area he then prospected were between 1s. 3d. and 4s. per cubic yard. In those days pipes were stacked on the property, but were not erected. Mr. Arthur Saxton went out in 1914 and put up the pipe line and started work. When he started work in June, 1914, his first big washing was roughly 18,000 cubic yards, giving a result of 1s. 7d. per yard, which really coincided in an extraordinary degree with the bore-holes and the pits sunk on this locality. The war came, and the property, being close to what was then German Togoland, had to shut down. The pit excavations made by this washing showed up further deeper gravels which had not been previously located by prospecting, and pits sunk from the bottom of this excavation gave the following results: No. 1 pit, at 11 ft. below bottom of pit excavation, 3s. 6d. per cubic yard; No. 2 pit, at 14 ft., 7s. per cubic yard; No. 3 pit, at 15 ft., 6s. per cubic yard; No. 4 pit, at 12 ft., 6s. 8d. per cubic yard; and No. 5 pit, at 13 ft., 5s. per cubic yard. The pipe line would be repaired and a gravel pump would be sent out to work these deeper deposits. With regard to the tonnage, Mr. Saxton estimated in round figures over one portion of 3,000 acres alone there existed 50 million cubic yards of gravel at 1s. 7d. per cupic yard, while working costs should not exceed 6d. per cubic yard. The shareholders must not look for returns of gold immediately, as a lot of work had to be done, but they ought to be getting returns towards the end of the year.

The proceedings then terminated.

TEHIDY MINERALS, LIMITED.

Directors : Oliver Wethered, C. A. Moreing, F. A. Robinson, H. Montagu Rogers, C. V. Thomas. *Secretary :* J. F. Maynard. *Office :* Camborne. *Formed* 1919. *Capital :* £40,000 in 40,000 shares of £1 each, of which 10s. is called up.

Business : The mineral development of parts of the Tehidy estate, Cornwall.

The statutory meeting of Tehidy Minerals, Limited, was held at the offices of the company, 20, Copthall Avenue, London, E.C., on June 12, Mr. Oliver Wethered presiding.

The Chairman said there was no resolution to move, but he would ask Mr. C. A. Moreing to give an account of the work so far done at the properties.

Mr. C. A. Moreing said: Although the company was only definitely constituted three months since, the property had been acquired by Dolcoath and East Pool many months previous to that date, and those two companies instructed Mr. R. Arthur Thomas and my firm, while awaiting the formation of the company, to have a detailed geological examination of the property made and also a series of plans co-ordinating the work of the various companies in the neighbourhood, accompanied by sections showing the lodes and geological features. This important work was entrusted to Dr. Malcolm Maclaren, well known as the most eminent of living mining geologists, and Mr. W. A. Macleod, who holds a position in the mining world equivalent to that of Dr. Maclaren in the field of geology and science. No such work as this has ever been carried out in Cornwall before. It has taken much time and cost a great deal of money to produce a number of important plans and sections. [These were exhibited on the wall at the meeting]. It is now for my firm and Mr. Thomas to advise the company as to how the important lodes, which are shown to exist in the granite to the north of the present range of workings, can be most expeditiously and advantageously worked.

The plans will show you the immense amount of work that has been done in the past. They will also show you the vast extent of the undeveloped ground. The amount of ground covered by this plan to the extreme east is something like three miles. You see the vast working carried out in the past, which represents the work of hundreds of years of Cornish industry. I suppose no other field in the world, except Johannesburg, has such a showing as we have here and the extent of working. The sections will show you the numberless lodes which are known, and which have produced great riches in the past, and will show you the depth at which these lodes enter respectively the greenstone, the killas and the granite, and it is sufficiently well known now, to those who are interested in Cornish mining, that whereas the greenstone sills as a rule carry no mineral, the killas, is especially renowned for its output of copper ores and a certain amount of tin and wolfram, but it is when the lodes penetrate the granite that their richness in tin becomes more pronounced. The sections show you, further, that the workings on most of these lodes to the north have not yet reached the granite, and therefore that their future is still before them; in fact, they are in the granite virgin lodes. The sections also show that the granite throughout is not at an unreasonable depth for exploration. You will notice on the section that the extreme limit of the granite is only 338 fathoms, whereas it is well known to all of us that in the Dolcoath mine tin has been and is being worked at a depth of over 500 fathoms. What, however, principally gives us all confidence in the future of these veins in the granite is the remarkable and comparatively recent discovery at East Pool of the strength and value of the Rogers lode where it enters the granite, whereas the same lode is broken up and of little value—except in places for copper—in the killas above. Having had that experience we believe these conditions will be reproduced in other cases.

It is now a well-established principle in the development of Cornwall that there are great possibilities in lateral development on these great lines of fissures, and I think I may take the credit to my firm of this method, which, it is now believed, will be the future salvation of Cornish mines. By this method it is no longer necessary to reopen old and abandoned shafts and exhaust great accumulations of water—underground lakes I might call them—but by means of modern methods, exploration with the diamond drill beneath the old workings and cross-cuts driven expeditiously and economically by the modern rock-drill from existing shafts, new mines can be opened up at comparatively small cost and in comparatively short time. Mr. Thomas and myself have only just received the plans, sections and reports of the engineers, and on this data we shall base our recommendations for the development of these lodes in your property.

I have confined myself in these few remarks to the development of the well-known lodes on the Redruth-Camborne line, but a glance at the plan of the surface will show you that this is a very small part of your property, which extends away to the north, east and west over a very large area. This country is unexplored, largely, I am told, because the late mineral owners—the Basset family—did not wish it to be explored because it interfered with the amenities of the Tehidy mansion and their farms. You will notice that your property includes practically the whole of the Red River, which, from time immemorial, has been worked by tributers, and immense quautities of tin have been produced from the alluvials of the river. In fact, we are led to believe that it was from this river that the Romans and Phœnicians obtained their supplies of tin. The mouth of this river is the property of your company, and is known as the Gwithian sands, well known in Cornwall. Mr. Wethered, your Chairman, has long been connected with the development of these sands, and he has kindly offered to Mr. Thomas and myself all the information he has with regard to them and the perusal of his sampling plans. It would appear to me that there is a possibility of profitably dredging these sands. There are other interesting developments which may possibly take place in regard to the whole of the river which we have not yet had time to consider. I think this is all I can usefully say to-day with regard to your property. It appears to me that it has vast possibilities and that it is even of national interest, and the time will come when it will be one of the leading mining factors connected with the whole development of the county of Cornwall.

SOUTH CROFTY, LIMITED.

Directors: Francis Allen *(Chairman)*, H. J. Meyerstein, Henry Lovegrove. *Secretary:* T. Wallace Evans. *Office:* 6, Broad Street Place, London, E.C.2. *Formed* 1906. *Capital:* £50,000 in shares of 5s. each. *Business:* Works a tin-wolfram-arsenic mine between Camborne and Redruth.

An extra-ordinary general meeting of South Crofty, Ltd., was held on May 14, at WinchesterHouse, E.C., Mr. Francis Allen, J.P. (Chairman), presiding.

The Chairman said: Gentlemen, this morning there is no occasion for me to call upon the secretary to read the notice convening the meeting or to mention the resolution which was to be put forward. Yesterday morning a letter was received from Colonel Micklem resigning his seat upon the board, and at a board meeting held this morning a resolution was passed formally accepting it. Before I read Colonel Micklem's letter it might be of interest to shareholders to know that 361 shareholders sent us their proxies. Those 361 proxies covered shares to the number of 134,924. I will now read to you the letter we received from Colonel Micklem:

7, King-st., St. James', S.W., May 12, 1919.

Dear Sir,—The limited number of proxies I have received for the meeting of South Crofty, Ltd., on May 14, satisfies me that the holders of the large majority of shares, with full knowledge of the question at issue, are not opposed to the policy you advocate. I, therefore, beg to notify you of my retirement from the board of the company. While I have not changed my own views in regard to it, I sincerely hope that the execution of your policy will be attended with success to the company.

Yours faithfully,

(Signed) H. A. Micklem.

The Chairman, South Crofty, Ltd.,
6, Broad Street Place, E.C.

There really remains nothing more for me to do this morning than to thank those shareholders who have been good enough to extend their confidence to us by sending in proxies in the way they have done. It is not often that one-half the shareholders in a company trouble to send in their proxies, but in this case they have done so—the number given is far larger than is usual. We do esteem the confidence extended to us, and venture to express the hope that it may be continued in future and may be justified by the way in which we carry on our work on behalf of the shareholders.

Mr. C. W. Brown proposed a vote of thanks to the Chairman, which was seconded by Mr. Langridge and carried unanimously.

The Chairman, in expressing his thanks, stated that Col. Micklem was present, and if he cared to say anything to the meeting they would be pleased to hear him.

Col. Micklem: I do not think there is anything more to say. The matter is settled, and the shareholders have expressed their views. There is only one remark I would like to make, and that is that, in spite of the differences, I wish the shareholders and the board the utmost success in carrying out their policy in the future.

The proceedings then terminated.

TRONOH MINES, LIMITED.

Directors: C. V. Thomas *(Chairman)*, S. H. Moore, F. D. Osborne, W. J. Payne. *Secretary:* A. H. Cullen. *Office:* 73, Basinghall Street, London, E.C.2. *Formed* 1909. *Capital:* £160,000.

Business: Operates alluvial tin mines in Perak, Federated Malay States.

The seventeenth annual general meeting of the Tronoh Mines, Ltd., was held on June 11 at the Cannon Street Hotel, London, E.C., Mr. C. V. Thomas (Chairman of the company) presiding.

The Chairman, in moving the adoption of the report and accounts, said that for the year under review the proceeds of tin ore sold had increased by a sum of no less than £108,760. This was made up by an increase in the quantity of tin sold of 323½ tons and an increase in value as compared with 1917 of £49. 1s. 8d. per ton, and it had been mainly owing to the better ground worked by the dredges. Bearing in mind what might be the wrong deductions of shareholders from the coming exhaustion of the main lead, to which he had made reference for several years past, it would be interesting for them to know the work done by these two dredges. No. 1, the smaller dredge, began to work in 1913, the intention of the then manager being to work upon the large accumulations of tailings. That was found to be useless, and they were indebted to the present general manager for the suggestion of enlarging that dredge, so that since 1915 this No. 1 dredge had been working at greater depths the tin on the banks of the Selensin River. The original cost of that dredge, plus the cost of alterations, was just over £13,000, whereas during the two years it had been working that little dredge had made a profit of £29,787, and last year, owing to its having got into some better quality ground, it gave a profit of rather over £26,000. The No. 2 dredge was the large one which they were operating in what they knew as No. 5 mine, and which they began to work in January, 1915. That dredge cost the company at the then prices just under £30,000, and during the four years it had been at work it had produced a profit to the company of £85,733, last year producing no less a sum than £47,537. That extra profit of last year, to which reference was made in the general manager's report and in the directors' report, arose from the fact that they found an extension of the Tronoh South lead running up into this company's land, so that the value of the ground treated by that No. 2 dredge last year rose from 0·46 catties per cubic yard in 1917 to 0·84 catties per cubic yard. Last year those two dredges between them contributed about 45% of the total output of the mines and 74% of the mine profit. The dredging cost in 1917 of No. 1 dredge was 7d. per cubic yard, while last year it was 8¾d. per cubic yard. Of No. 2 dredge it was 5¼d. in 1917 and 5½d. in 1918, so that shareholders would see with anything like the present prices for tin and anything like the values that were now being found by that dredge there would be a good margin of profit.

Mr. Walter J. Payne seconded the motion, which was carried unanimously.

LENA GOLDFIELDS, LIMITED.

Directors: Lord Harris (*Chairman*), F. W. Baker, G. Benenson, H Guedalla, Sir Leigh Hoskyns, J R. Mason. *Secretary* Henry Richards. *Office:* 441, Salisbury House, London, E C.2. *Formed* 1908. *Capital:* £1,405,000.

Business: Holds shares in the Lenskoie, a Russian company working gold gravels in East Siberia.

The ninth annual ordinary general meeting of the Lena Goldfields, Ltd., was held on June 11, at Salisbury House, London, E.C., Lord Harris (Chairman of the company) presiding.

The Chairman, in moving the adoption of the reports and accounts for the years ended September 30, 1917, and September 30, 1918, said that cablegrams from the manager at Lenskoie had recently got through, briefly indicating that the mines were being worked, but that supplies were very short. Of course, they knew that the dredging policy, approved before the war, could not be introduced for some years yet, though the first dredge had been built, and was waiting in the United States for shipment; but they had hopes that the Chanchik channel was giving indications of rich deposits, which would make up to some extent for the postponement of dredging operations. The position was that there was still much gold to be got out by drifting, that it must be of the utmost importance to the Government to get it, and, therefore, that the company might be earning profits. The information in yesterday's papers that a Bolshevik force had seizedthe minefield was very discouraging, but in the absence of confirmatory advice he declined to accept the statement as an established fact.

As regards the accounts, whereas they started in 1915-16 with a cash balance of £613,871 odd, they closed the year 1917-18 with a cash balance of £862,505. The transactions during that period had been of considerable volume and of some importance. Among them were the sales of Lenskoie shares and the issue of Lena Goldfields shares to the group composed of the Imperial and Foreign Corporation, the Russian and English Bank, and Mr. Benenson. The policy of these sales and the issue had been set before the shareholders at previous meetings and had been approved. The result of the first sale in 1915-16 was £245,634 in sterling; in 1916-17 the amount received was £321,721 in sterling; there was the premium on the issue of 246,703 Lena Goldfields shares; and in 1917-18 the receipts from that issue were £241,703, also in sterling These sales had produced a very distinct change in the assets and liquid position of their company. Whereas previous to 1915-16 it was a company interested in one asset only—namely, its holding in Lenskoie—looked to by that company for financial assistance to enable it to carry on from year to year its purchase of stores, and only able to provide the assistance by Lena Goldfields borrowing in this country, they were now in a very strong financial, and in a very liquid position. One of the reasons which finally induced the British directors to accept the offers from the group referred to was the recommendation of the expert committee which strongly recommended a change in mining operations from drifting to dredging. That policy having been decided on, and it was the only method, as it appeared to the committee, by which a long life could be assured to the mines, it was necessary to look forward and arrange for the provision of considerable sums of money for the purchase of the dredges which it was contemplated should be established on the minefield. The war had, of course, upset the whole scheme for the time being, but, at the time when this method of financing was recommended by the majority of the board and was approved at the annual general meeting, the Lenskoie Company had no prospects of itself being able to finance the provision of dredges and depended upon Lena Goldfields doing so. Since then Lenskoie had been successful in doubling its capital, and, subject to what might happen as regards Russian currency, should be in a much better position in the future to finance the provision of other dredges.

The postponement of the provision of further dredges and the utter inability, during the war, of their company to finance Lenskoie as regards mining necessaries, had, of course, resulted in this company having large liquid resources in British sterling, which it had used partly for the purchase of War Loan, and partly, since the end of the financial year, in investment in various mining and industrial concerns, ensuring a handsome profit if they thought it wise to realize, or, if they thought it wiser to hold them, showing every promise of satisfactory dividends. Since the close of the financial year they had realized some of these investments at a considerable profit. In purchasing War Loan they felt thoroughly justified; it assisted towards bringing the war to a conclusion, and it followed on the precedent of a large purchase of Russian Treasury bonds. The drawing of these latter for payment had resulted in a large rouble deposit in Russia, which they had no means of withdrawing, and all they could do was to await events as regards the future Russian currency question. The same applied to their last sales of Lenskoie shares to the group. They had to pay the company in roubles at 450 roubles per share, and elected to do so in London as regards the first payment for one-third of the transaction. The company would still hold nearly 20,000 Lenskoie shares after the transaction referred to was completed, and until it was completed they held the scrip.

Their liquid resources were £657,195, a very different position from what it was previous to the sales and issue referred to; a position which enabled them to take opportunity of investment in any part of the world and of which they were taking advantage.

He regretted very much to have to refer again to the disputes that occurred between Messrs. Poutiloff and Wischnegradski and the directors resident in England. He referred to them at great length at the last meeting, and would not weary shareholders with a repetition. Their resignation, which they contemplated at the time, was withdrawn, and they remained members of the board until quite recently, when, owing to the attitude of persistent unfriendliness which their alternates, by their direction, took toward the Russian and English Bank, the board felt bound to ask them for an explanation. That had not been forthcoming, or, such as it was, was entirely insufficient and unsatisfactory. The result had been that both Mr. Wischnegradski and Mr. Poutiloff had retired from the board.

Mr. G. Benenson seconded the resolution.

After some discussion with regard to the sale of Lenskoie interests and the resignation of the two Russian directors referred to by the Chairman, the resolution was put to the meeting and carried.

BRITISH BROKEN HILL PROPRIETARY CO., LTD.

Directors : J. S. Smith-Winby *(Chairman)*, F. S. Saunders, Alexander Stewart, W. H. Woodhead, W. J. Magarey, J. K. Samuel, F. V. Sanderson. *Secretary pro tem.:* E. E. Garner. *Office :* Salisbury House, London E.C.2. *Formed* 1887. *Capital : £*339,000.

Business : Operates a lead-zinc-silver mine at Broken Hill, New South Wales.

The thirty-ninth ordinary general meeting of the British Broken Hill Proprietary Company, Ltd., was held on June 12 at Salisbury House, London, E.C., Mr. J. S. Smith-Winby (Chairman of the company), presiding.

The Chairman, in moving the adoption of the report and accounts, said that, taking the accounts for the two half-years together, a profit was shown, after providing for administration, depreciation of plant, and loss on realization of investments, of £214,166. This amount was about £80,000 in excess of the previous year, but was subject to a big deduction for income tax and war taxes under various denominations that they were called upon to pay both in Great Britain and Australia. No less than £60,000 was being reserved for that purpose, and in the accounts for the second half of last year this provision had accordingly been made. In respect to the results of last year, they had already distributed two dividends, free of income tax, the first of 2s. per share at the end of June last and the second of 4s. per share in December. They had every hope and expectation of being able to recommend another dividend this June, but circumstances had arisen during the last few months which made it necessary to defer for the present any further distribution. Their production consisted of lead, zinc, and silver. With zinc and silver they were experiencing no difficulty. As regards zinc, the purchase by the Imperial Government of the entire production of Australian concentrates was for the period of the war and ten years thereafter. For silver there was a ready market at advanced prices. But as regards lead a difficult, and to some extent unanticipated, position had arisen. They and the other Broken Hill Mines had combined through the medium of the Broken Hill Associated Smelters Co., and had placed their lead business unreservedly in the hands of the British Government. The lead contract with the Government expired on March 31, and though the Associated Smelters had reason at one time to think it would be continued at any rate for some months, this was not done. The Government stock of lead was a heavy one, and civilian consumption owing to the continuance of the general dislocation of business, represented only a small fraction of the normal requirements. The situation was consequently full of difficulty, but, so far from assisting it, the Government laid down a policy which did not appear to have any regard to mining interests. Their first move in the direction of liquidating their surplus holding was to raise the price of lead to £40 a ton. Thus in the face of exceedingly poor consumption, they took a step which could only, and did, have the effect of encouraging increased production by competitors who had no reason to particularly consider the wishes of the British Government, or at any rate were not subject to the same restraint or restriction as the Associated Smelters. On November 11 the Government price of lead was £29. On the 26th it was raised to £40. Clearly it could not stop there long, and it had since dropped away to £23 and was now still lower. This had had the effect of checking confidence among consumers. From the moment that the Associated Smelters became aware that the Government lead contract would not be continued after March 31 they had been actively engaged in trying to overcome the difficulties with which they were faced, one of the greatest being that of transport, as the transport arrangements were entirely under Government control. After very hard work shipment of lead from Australia recommenced. The quality of the product and the support of customers in this country were both favourable factors, and all the lead that had been possible to ship had been realized.

The difficulty at the moment was to correctly define the immediate position, and it looked as if it might be six months, or possibly more, before the situation could be accurately gauged. In the meantime, it was obviously necessary to husband resources. The Associated Smelters for the time being could not make advance payments for lead concentrates, and they and the other mines were thus for the first time left with the obligations of financing their entire operations from the winning of the ore to the realization of the products. This necessarily made a considerable strain upon their finances, and though they were in a substautial condition their working capital would be quite inadequate to continue production under present circumstances for an indefinite period. Therefore at this juncture following the example of the North and South Mines, they were reluctantly compelled to pass the usual June dividend and ask shareholders to wait until the present situation had been relieved.

As to the operations at the mine, production during the past year was well kept up, without, however, unduly encroaching on the reserves. The ore developed since the previous estimate was exceeded by the ore extracted. At the end of December last Mr. Emery estimated the reserves at 1,095,015 tons of ore of an average assay value of 6·7 oz. of silver, 12·8% lead, and 11·6% zinc, a net increase in quantity of about 40,000 tons, with a slight falling off in average value of contents. Mr. Emery also stated that an appreciable quantity of carbonate ore remained to be extracted. There was another matter that was giving a good deal of anxiety, and that was the ever-increasing mine costs at Broken Hill. Comparing the first and second portions of last year, the working costs per ton to the end of June were 20s. 8·62d. for ore raising, 7s. 0·26d. for lead mill treatment, and 5s. 1·67d. for zinc mill treatment. The corresponding figures to December were 22s. 3·73d., 7s. 8·25d., and 5s. 5·66d. or a total increase of nearly 3s. 3d. per ton. Every effort was being made to keep down these costs. The present prices of mining requisites, particularly timber and coal, were enormous, and the demands of labour, or, rather, of labour leaders, seemed to be insatiable, notwithstanding the big rise in wages given last October.

The Chairman then gave some particulars as to the labour position, and referred to the present strike.

Mr. F. S. Saunders seconded the motion, and it was carried unanimously.

SONS OF GWALIA, LIMITED.

Directors: David Richards *(Chairman and Managing Director)*, John Barry, Sir G. P. Doolette, C. Algernon Moreing. *General Managers:* Berwick, Moreing & Co *Secretary:* E. Pears *Office:* 20, Copthall Avenue, London, E C. *Formed* 1898 *Capital issued:* £325,000
Business: Operates a gold mine at Mount Leonora, West Australia.

The twenty-second ordinary general meeting of the Sons of Gwalia, Ltd., was held on May 20, at the registered office, 20, Copthall Avenue, London, E.C.2, Mr. David Richards (Chairman and managing director) presiding.

The Chairman, in moving the adoption of the report and accounts for 1918, said that war conditions had more than ever affected the company's operations. Higher costs in every direction told a sorry tale in results; in fact, nearly every item was adverse. In the last two years he had indicated that costs per ton were creeping dangerously close to the value of the ore produced, and this year the margin had run off altogether. He hoped this would be temporary, but costs—that is, labour—dominated the position. The accounts rendered in 1915 showed costs of 17s. 9d. per ton, excluding development. This year they were 21s. 0½d., causing a difference in profit of £25,000, and making practically a clean sweep of the earnings. The accounts showed £12,720 of profit, but nothing had been written off capital and only some £20,000 was spent upon development, instead of the usual £35,000. Every penny of surplus over actual expenditure went in Imperial and Colonial taxation. Some comfort was afforded by the fact that the refilling scheme was partly responsible for the increased costs. The refilling of the stopes was practically completed. Before this work was done there was frequently much difficulty in getting at certain faces, and at times during 1918 many of the better stopes were altogether inaccessible. He believed these difficulties were only temporary. The Gwalia was a low-grade proposition, and success depended upon a sufficiency of working capital, good and efficient labour, and capable management. They claimed to have the first and last of these essentials. In 1914 they treated 161,000 tons for a product of £250,000 and a gross profit of £72,000, and paid 3s. per share dividend. In 1918 they treated 148,000 tons or within 13,000 tons of 1914, and were left without a penny for themselves. Continued demands were made for higher wages, and at the same time labour was less and less efficient. The object of trade unions appeared to be to kill capital. The company's capital was just over £200,000, provided by many thousands of small shareholders. With normal and reasonable labour conditions the mine looked capable of moderate dividends for an indefinite number of years. But labour persisted in a policy of continued unrest, of demanding more and more wages and shorter and shorter hours. Although the amount of new ore opening out had been below the average, the mine continued to show good ore at the bottom, and this was a heartening feature among many adverse conditions.

Sir George P. Doolette, J.P., seconded the motion, which was unanimously adopted.

PLYMOUTH CONSOLIDATED GOLD MINES, LTD.

Directors: David Richards *(Chairman)*, John Barry, W. J. Loring, C. A. Moreing *General Managers:* Berwick, Moreing & Co. *Secretary:* F. A. Crew. *Office:* 20, Copthall Avenue, London, E.C.2 *Formed* 1914. *Capital:* £240,000.
Business: Operates a gold mine in Amador County, California.

The sixth ordinary general meeting of the Plymouth Consolidated Gold Mines, Ltd., was held on May 21 at 20, Copthall Avenue, London, E.C., Mr. David Richards (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said the mine was a particularly steady-goer and managed year after year to run on a very level keel. This year had followed in the footsteps of the preceding years with quite commendable regularity in respect of both amount of output and value of gold won. Costs had again risen, but the mine had come to the rescue and found some compensation by way of higher grade. Working costs were 15s. 11d. as against 14s. 2d. in 1917, but there was a higher recovery value of nearly 1s. Two dividends, each of 1s. per share, were paid, as in the preceding year. Rather more than the average amount of development work had been carried on within the year 1918, no less than 6,681 ft. of driving, rising, and cross-cutting being done, as compared with about 5,017 ft. in 1917. Much of the development work was directed to opening-out on the 2,600 ft. and 2,450 ft. north. Both of these levels have opened-out fair quantities of more than average value ore. At the 2,600 ft. for instance, which was the bottom level, ore averaging 35s. had been opened up, which was excellent. During the year no shaft-sinking was done, but it was intended to resume sinking during 1919. To the south of the shaft, where a very large proportion of the output had been obtained for some years, development was continued and attended by most satisfactory results. On the 1,400 ft. level one of the shoots which had been developed in the levels above was opened up and also showed very excellent values averaging 39s. This was also encountered below at the 1,500 ft., where the average value was 37s. Since the close of the year this shoot has been developed at the 1,600 ft. and continued to give fine values, the average being 45s. per ton over a width of more than 13 ft. Further south (on the 1,400 ft. level) another shoot, which had been previously opened out on the 1,200 ft. level had been developed and disclosed high-grade ore, averaging no less than 43s. per ton over good widths. Work was now being concentrated upon the proving of these shoots at the deeper levels. These values were very splendid indeed when it was borne in mind that the average ore milled at the Plymouth had only been about 22s. recovery value, and from which they had been making their dividends. It was pleasing to tell shareholders that their property looked so well. The Plymouth certainly promised well as a future dividend-payer.

Mr. John Barry, J.P., seconded the motion, which was carried unanimously.

BALAGHAT GOLD MINING CO., LTD.

Directors: Lord Ribblesdale (*Chairman*), Lord Glenconner, Lt.-Col. Sir Donald Robertson, John Taylor, Robert Taylor. *Managers*: John Taylor & Sons. *Secretary*: W. L. Bayley. *Office*: 6, Queen Street Place, London, E.C. 4. *Formed* 18[illegible], reconstructed in 1[illegible], 1[illegible], and 1[illegible]. *Capital*: £212,600 in ordinary shares and £95,400 in preference shares.

Business: Operates a gold mine in Kolar district, Mysore State, South India.

The twenty-third ordinary general meeting of the Balaghat Gold Mining Company, Ltd., was held on May 29 at the registered offices, 6, Queen Street Place, London, E.C., the Right Hon. Lord Ribblesdale (the Chairman) presiding.

The Chairman, in moving the adoption of the report and accounts, said that during the twelve months 26,745 tons of quartz were treated at the mill and 19,710 oz. of bar gold were obtained therefrom; 54,130 tons of sands and slimes were dealt with yielding 4,836 oz. of gold, the total production having been 24,546 oz. of bar gold, equal to 22,135 oz. of fine gold, the sale value being £93,835. The value of the gold produced during the year under review was £9,398 more than in 1917. This improvement was due to a higher grade of ore having been crushed at the mill and a better extraction having been obtained. The total receipts on revenue account, after deducting royalty paid to the Mysore Government, amounted to £87,871 and the payments to £84,799, leaving a profit of £5,072. At the commencement of the year there was a debit of £22,940 standing to profit and loss account, and after allowance for depreciation the year ended with a debit balance on profit and loss account of £21,151. 19s. The reserves of ore at the end of the financial year were estimated at 38,614 tons, as compared with 30,076 tons reported at the end of 1917. The reserve of sand and slime at the same date was estimated at 10,000 tons, in addition to which there were 270,000 tons of sand in the old heap, which could profitably be re-treated. In the directors' report for the year 1910 shareholders were informed that a curtailed programme of work underground had then been adopted, so that the costs of development should not exceed the revenue receipts. Owing to financial necessity, this policy had been pursued up to the present, but even this comparatively small amount of exploratory work had been the means of opening up substantial bodies of payable ore, which had considerably improved the prospects of the mine. The fact, however, remained that the restricted underground operations had seriously hampered the mine's progress. The mining outlook was brighter now than it had been for many years past. There was little doubt that the progress of operations underground had given a new view to the board and the managers of the prospects of the Balaghat property. In the opinion of the directors and managers there was ample justification for increasing the scope of the work underground, and the financial position of the company was therefore receiving the consideration of the board. They had decided to recommend the shareholders to provide additional capital for the purpose of extending the scope of the underground operations, which would materially strengthen the mining position, and should be the means of increasing the working profit.

Mr. John Taylor seconded the motion, and after Mr. Henry C. Taylor had given details of the mining operations during the year, the motion was put to the meeting and carried unanimously.